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ART. I.—*Results derived from an examination of the United States Weather Maps for* 1872, '73, *and* '74; by ELIAS LOOMIS, Professor of Natural Philosophy in Yale College. Third paper. With Plate I.

[Read before the National Academy of Sciences, Washington, April 20, 1875.]

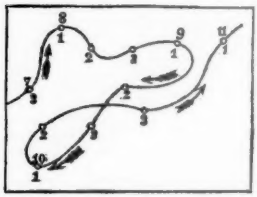
IN this Journal for July, 1874, I gave the average direction of storm paths and the velocity of progress for each month of the year as deduced from 314 cases in 1872 and '73. I have made a similar examination of the weather maps for 1874, and now present the results derived from 171 cases for that year, together with the average results derived from combining all the observations of the three years, making in the aggregate 485 cases.

	Results for 1872 & 73.		Results for 1874.		Results for 3 years.	
	Course of storm.	Velocity in miles per hour.	Course.	Velocity.	Course.	Velocity.
January	N. 85° E.	28·5	N. 74° E.	23·0	N. 81° E.	26·7
February	76	31·0	70	33·9	74	32·0
March	79	30·8	86	29·8	81	30·5
April	74	25·6	68	31·4	72	27·5
May	78	24·2	76	22·2	77	23·5
June	93	21·2	81	22·4	89	21·6
July	102	24·4	88	25·9	97	24·9
August	85	17·7	85	19·9	85	18·4
September	78	22·8	70	23·1	75	22·9
October	69	24·4	84	28·5	74	25·8
November	80	28·3	74	30·3	78	29·0
December	84	27·6	81	32·7	83	29·3
Year,	N. 82° E.	25·6	N. 78° E.	26·9	N. 81° E.	26·0

The average course of the storms in 1874 was four degrees more northerly than for the two preceding years, and the average velocity was 1·3 miles per hour greater; but the change both in the direction and velocity depending upon the season of the year was similar to that before noticed. According to the combined results derived from the three years observations, the course of storms is most southerly in July, and most northerly in April and October, the mean difference between the extreme months amounting to 25°. The velocity of progress is greatest in February, and least in August, the former exceeding the latter by 74 per cent. In only one instance was the course of a storm for an entire day directed toward a point west of north. This occurred on the 18th of April, in the case of a storm which originated in the Gulf of Mexico, and whose course for one day was 13° west of north. The most southerly direction for the year occurred in the case of the storm of Aug. 21st, whose course for one day was N. 163° E., or S. 17° E., a directional most exactly opposite to that of the storm of April 18th.

The most rapid progress of a storm center observed in one day occurred Feb. 22nd, being 1280 miles, or 53·3 miles per hour; and the least velocity occurred Aug. 21st, being 228 miles in 24 hours, or 9·5 miles per hour.

These are the results derived from observations made at intervals of 24 hours. If we make the comparison at intervals of eight hours, we shall find much greater variations in respect to both direction and velocity. According to the monthly maps, published under the direction of the Chief Signal Officer, from the 7th to the 11th of May, 1874, the path of a storm center situated about 300 miles west of Lake Superior was such as is represented by the annexed diagram; where the figures above the curve line show the days of the month, and those below 1, 2, 3, indicate respectively the 7.35 A. M., 4.35 P. M. and 11 P. M. observations. It will be perceived that the direction of the storm's progress changed more than 180° in 24 hours, and on the morning of the 11th the center of the storm was distant less than 100 miles from its position on the morning of the 9th. If, then, we regard the actual motion of the storm's center from hour to hour, as remarked in my former article, we find that the storm path may have any direction whatever, and the velocity of progress may vary from 15 miles per hour toward the west, to 60 miles per hour toward the east.



Diurnal inequality in the progress of storms.

In order to ascertain whether the progress of storms is uniform throughout the entire day, I availed myself of the monthly maps issued by the Signal Service Bureau. These maps show the position of the storm centers for three hours of the day, viz: at 7.35 A. M., which is designated by (1); at 4.35 P. M., which is designated by (2); and at 11 P. M., which is designated by (3). On each storm track, the distance from 1 to 2, from 2 to 3, and from 3 to 1 (of the next day), was carefully measured on a scale of inches, and these distances were afterward reduced to miles by computation. The total distance traveled by a storm center during each interval was divided by the number of hours in the interval, and thus the hourly velocity of progress obtained for three different portions of the day. The following table shows the average results of this comparison for the storm paths for 1873 and 1874. The numbers given in column second represent the average hourly velocity in miles for the interval from 7.35 A. M. to 4.35 P. M.; the numbers in column third for the interval from 4.35 P. M. to 11 P. M.; and the numbers in column fourth represent the velocity from 11 P. M. to 7.35 A. M. of the following day.

	1–2	2–3	3–1		1–2	2–3	3–1
Jan.	26·6	37·3	28·2	July	25·2	32·6	28·2
Feb.	28·6	37·0	28·9	Aug.	24·2	28·6	20·8
March	27·2	33·6	27·2	Sept.	23·9	30·2	24·5
April	22·5	25·9	22·9	Oct.	22·9	29·6	23·5
May	19·2	25·6	19·5	Nov.	33·6	40·6	29·3
June	22·5	25·9	22·2	Dec.	33·3	37·0	29·9
				Year,	25·9	31·9	25·4

From this table it appears that the average velocity of storms from 4.35 P. M. to 11 P. M. is about 25 per cent greater than it is for the remainder of the day. This excess varies for the different months, ranging from 14 to 32 per cent, but in each month the most rapid progress occurs during the same portion of the day.

This diurnal inequality is doubtless connected with a diurnal inequality in some one and perhaps several of the other meteorological elements. Its maximum value apparently occurs about 7 P. M. Now this is not the hour of the maximum force of the wind, nor of the maximum or minimum temperature, and hence it may be presumed that the inequality does not depend directly upon the velocity of the wind nor upon the absolute temperature. This hour (7 P. M.) is, however, the time when the temperature of the day is declining most rapidly,

and this condition must be favorable to a rapid extension of the rain-area in front of a storm. When, at a given place in front of a storm center, a system of causes is in operation which is soon to result in a fall of rain, the ordinary change of temperature at evening must accelerate the commencement of the rainfall; that is, must extend the rain-area more rapidly, and this, we have seen in a former article (this Jour., vol. viii, p. 3), must increase the velocity of the storm's progress.

This extension of the rain-area in front of a storm does not perhaps necessarily imply an increase in the average rainfall for that part of the day; nevertheless, I have endeavored to determine whether there is a diurnal inequality in the fall of rain. For this purpose I first examined the observations made at Girard College, Philadelphia, from 1840 to 1845, but found only seven months (viz: Jan., March, June, July, Aug., Sept., Oct., 1843) in which the self-registering rain-gauge is reported to have been in good condition. In the following table, column second shows the aggregate amount of rain at Philadelphia for each hour of the day during these seven months.

Rainfall at Philadelphia.

Hour.	Rain, Inches.	Average.	Hour.	Rain, Inches.	Average.
Midnight	1·633	0·869	Noon	0·366	0·914
1 A.M.	0·748	·917	1 P.M.	·783	·861
2	·398	·826	2	1·438	1·036
3	·666	·636	3	0·869	1·152
4	·686	·677	4	1·727	1·265
5	·684	·731	5	0·945	1·234
6	·949	·716	6	1·346	1·580
7	·671	·733	7	1·285	1·310
8	·588	·822	8	2·598	1·206
9	·771	·802	9	0·375	1·165
10	1·133	·741	10	·427	1·235
11	0·848	·780	11	1·140	0·865

As these numbers show considerable irregularities, I have taken the average of each successive five numbers in column second and set down the results in column third. These resulting numbers show a pretty steady progress from a minimum at 3 A. M. to a maximum about 6 P. M., and from thence a steady decline to the following minimum. The maximum is nearly $2\frac{1}{2}$ times the minimum, although the former is made too small and the latter too great by the mode of reduction employed. It seems probable, therefore, that the diurnal inequality in the rainfall, as indicated by these observations, is a law of the Philadelphia climate, and we may presume, therefore, that it is a law for the immediate vicinity of Philadelphia.

I next examined the observations made at the signal service

stations for Sept., Oct., and Nov., 1872, these being the only months for which the observations have been fully published, and I confined the comparison to those stations which are north of lat. 35°. The total rainfall for a month at all the stations north of the parallel of 35° was determined for each of the three intervals into which the day is divided; these results were divided by the number of days in the month, giving the average daily fall for each of these intervals; and these last results were divided by the number of hours in the corresponding interval, giving thus the average hourly rainfall for all the stations for these three portions of the day. The following is the final result:

Hourly rainfall at the S. S. Stations.

	1–2	2–3	3–1
September	0·244 inch	0.308 inch	0·288 inch
October	·174	·200	·192
November	·155	·143	·180
Mean	0·191	0·217	0·220

These numbers indicate that the average rainfall for the stations employed is nearly uniform throughout the day. If, then, there is a decided diurnal inequality in the rainfall at Philadelphia, it seems probable that for other parts of the country the maximum takes place at a different hour, so that in taking the aggregate for a series of stations stretching across the continent, the total rainfall is nearly uniform for all hours of the day.

The British Government has published the hourly observations of rainfall for eleven months of the year 1874 at seven stations, viz: two in Ireland, two in Scotland, and three in England. From these observations it may be inferred that not only the absolute amount of rain, but also the time of maximum, depends very much upon the locality. In the aggregate for the seven stations there are indications of two daily maxima, one at 5 in the morning, and the other at 7 in the evening, with minima near noon and midnight; but since the fall of rain is dependent upon such a variety of causes, it is hazardous to draw general conclusions, except from a long series of observations.

Influence of rainfall upon the course of storms.

In a former paper (this Jour., vol. viii, p. 4) I endeavored to show the connexion between the velocity of a storm's progress and the extent of the rain-area on the eastern side of the storm. I have made a similar comparison of the observations of 1874, and now present the results. The number of cases suited to

this comparison in 1874 was 80; and I have divided them into four equal classes, the first division embracing those cases in which the progress of the storm in one day was at least 855 miles; the second, those cases in which the progress was from 855 to 665 miles; the third, from 665 to 490; and the fourth embracing the cases in which the progress was less than 490 miles in one day. In the following table, columns one and two show the results heretofore published, derived from the observations of 1872 and '73; columns three and four show the results derived from the observations of 1874, while columns five and six show the results derived from combining the observations of the three years.

Obs. of 1872 and 73.		Obs. of 1874.		3 years obs.	
Velocity in miles per hour.	Extent of rain-area in miles.	Velocity.	Rain-area.	Velocity.	Rain-area.
38·8	590	42·7	740	40·1	640
28·5	548	30·7	609	29·2	568
21·6	503	23·7	611	22·3	539
14·5	365	17·0	535	15·3	422

Although the velocity of progress does not appear to be strictly proportioned to the eastward extent of the rain-area (for the observations are seldom sufficiently numerous to indicate precisely the extent of this area, and it is plain that there are other causes which contribute to influence the result), yet I think it is well established that an unusual extension of the rain-area is generally accompanied by a velocity of progress greater than the mean. The result of the three years' observations shows the average extent of the rain-area eastward from the center of the storm to be 542 miles. When the eastern extent of the rain-area is 100 miles greater than the mean, the hourly velocity of the storm's progress is increased 13·7 miles: but when the eastern extent of the rain-area is 100 miles less than the mean, the hourly velocity of the storm's progress is diminished 9·5 miles.

I have also determined the influence of the rain-area upon the direction of the storm's path, as shown by the observations of 1874, in the same manner as described in my former paper (this Jour., vol. viii, p. 5). The following table shows: first, the results heretofore published; second, the results derived from the observations of 1874; and third, the results derived from combining the observations of the three years.

Obs. of 1872 and 73.		Obs. of 1874.		Obs. of three years.	
Course of Storm.	Axis of Rain-area.	Course of Storm.	Axis of Rain-area.	Course of Storm.	Axis of Rain-area.
N. 40° E.	N. 53° E.	N. 53° E.	N. 54° E.	N. 44° E.	N. 53° E.
N. 116 E.	N. 118 E.	N. 100 E.	N. 109 E.	N. 111 E.	N. 115 E.

From the result of three years' observations, it appears that when the course of a storm is most northerly, the axis of the rain-area is inclined to the storm's path 9° toward the south; but when the course of a storm is most southerly, the axis of the rain-area is inclined to the storm's path only 4°. If, then, in any case we can learn the precise limits of the rain-area about a storm-center, we ought to be able to predict with considerable confidence the direction and velocity of the storm's progress.

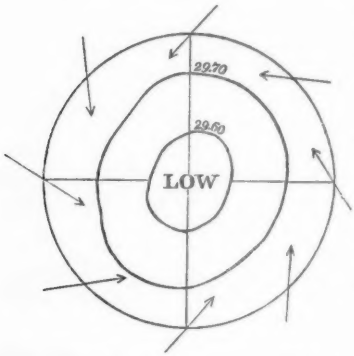
Influence of a neighboring area of high barometer upon the progress of a storm.

In order to determine the influence of a neighboring area of high barometer upon the progress of a storm, I selected all those cases in which a weather map showed both a storm center and an area of high barometer. I then divided the cases into eight classes, according to the direction of the center of high barometer from the center of low barometer. From the center of low barometer I drew eight radii, making with each other angles of 45°, and so situated that two of the octants should be bisected by a meridian line. These octants are designated by the terms, north, northeast, east, etc. A large sheet of paper was then ruled with appropriate divisions for each of the octants, and when the area of high barometer was on the north side of the storm center, the velocity and direction of the storm's path were entered in the column headed north. I proceeded in like manner with each of the cases in succession. An average was then taken of the directions and velocities in the several columns.

The following table shows the result of this comparison for 1872, '73 and '74. Column 1st shows the direction of the area of high barometer from the storm center; column 2d shows the number of cases employed; column 3d shows the average velocity of the storm's progress; and column 4th shows the direction in which the storm advanced.

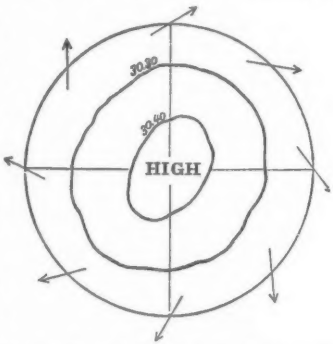
Direction of high barometer.	No. of Cases.	Velocity of Storm.	Direction of Storm-path.
North	23	26·0	N. 58° E.
N.E.	39	26·4	54
East	90	25·4	83
S.E.	75	29·5	90
South	25	30·3	93
S.W.	20	26·1	81
West	37	28·8	70
N.W.	19	28·7	62

The influence of a neighboring area of high barometer upon the velocity of a storm's progress is not very decided, nevertheless the observations indicate that when the high barometer is on the east side of the storm, the velocity of the storm's progress is diminished eight per cent; and that the velocity is increased by about the same amount when a high barometer is situated on the south side of the storm.



The effect of an area of high barometer upon the direction of a storm's progress seems to be more decided, the course of the storm being most northerly when the high barometer is on the northeast side, and most southerly when the high barometer is on the south or southeast side; in each case the storm-path is deflected toward the center of high barometer.

By referring to my former article (this Journal, vol. ix, p. 2) it will be seen that on whichever side of a storm center an area of high barometer is situated, both systems tend to impress nearly the same direction upon the intermediate air. It seems, therefore, that the immediate effect of an area of high barometer must be to extend the area of the wind which belongs to that side of the storm, and probably also to increase the velocity of the wind upon that side of the storm which is toward the high barometer. If, then, the high barometer is on the southeast side of the storm's center, the south wind which



belongs to that side of the storm should extend to a greater distance, and probably blow with increased force, which would cause increased rainfall upon that side, and the storm's path would incline in that direction. In like manner, if the high barometer were on the north side of the storm's center, the increased precipitation on that side should cause the storm's path to incline more to the northward.

It might be supposed that the same course of reasoning would lead us to conclude that a storm's progress should be most rapid when there is an area of high barometer on its eastern side. To this it may be answered, that although the fall of the barometer in such a case should be more rapid than usual, still, as the barometer starts from a point unusually high, the fall must continue for a proportionally longer time before the minimum is reached. The same consideration may in part explain why the progress of a storm is not as much accelerated by a high barometer on the northeast side as it is by a high barometer on the southeast side. In the former case, the high barometer is nearer to the track which the storm is to pursue, and there must be a greater fall of the barometer before the minimum is attained.

Form of the isobaric curves.

In my first article (this Jour., vol. viii, p. 11) I gave some comparisons illustrating the form of the isobaric curves about a storm center, as shown by the weather maps of 1872 and '73. I have made a similar comparison for the storms of 1874, and with the following results: The number of cases found suited to this kind of comparison was 75. In 35 of these cases (that is, 47 per cent of the whole) the major axis of the isobar measured was at least double the minor axis. In 15 cases (that is, 20 per cent of the whole) the major axis was at least three times the minor axis; and in 5 cases (that is, 7 per cent of the whole) the major axis was at least four times the minor axis. The average form of the isobars about a storm center may be said to be an irregular oval, whose length is nearly double its breadth. In order to give a more distinct idea of the form of these curves, I have selected the storm of March 29, 1873, and have represented several of the isobars on the accompanying chart, Plate I. It will be seen that the longer diameter of these curves is nearly three times the shorter diameter. The arrows show the direction of the wind at the signal service stations, and the force of the wind is partially indicated by the length of the arrows; a length of 0·4 inch indicating a velocity of at least 20 miles per hour; a length of 0·3 inch a velocity of from 10 to 20 miles; and a length of 0·2 inch a velocity less than 10 miles per hour.

An inspection of this map will show that the centrifugal force arising from the circulation of the wind around the storm center cannot be the principal cause for the fall of the barometer, for otherwise the form of the isobars would be more nearly circular.

With regard to the direction of the major axis of the isobars, there is but little tendency to uniformity; nevertheless, the most prevalent direction is about N. 35° E., which is almost identical with the result derived from the observations of 1872 and '73.

Great and sudden changes of temperature.

In a former paper (this Jour., vol. ix, p. 8) I called attention to the great and sudden changes of temperature frequently experienced in the United States and in other parts of the world, and suggested an explanation of this phenomenon. I will now present some additional facts bearing upon the same question. In the Report of the Chief Signal Officer for 1873 is given the maximum and minimum temperature of each day in 1873 at 40 stations in the United States and Canada. I have examined these tables to find all the cases in which the difference between the maximum and minimum of the same day amounted to at least 40°. The following table shows all the stations at which so great a difference was observed, and also the number of cases which occurred each month.

Diurnal Change of Temperature of 40° *and upwards in* 1873.

	Lat.	Lon.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	° ′	° ′													
Denver	39 44	104 58	3	5	5	2	2	6	4	3	4	*	1	2	37
Fort Sully	44 39	100 40	3	--	2	4	--	1	--	1	5	9	--	1	26
Cheyenne	41 12	104 42	1	1	--	1	--	4	3	--	2	3	3	2	20
Virginia City	45 0	112 3	2	--	*	*	*	2	1	*	*	1	2	3	11
Breckenridge	46 16	96 38	1	--	--	--	--	1	1	--	--	5	--	--	8
Fort Garry	49 52	96 58	--	--	--	--	4	--	3	--	1	*	*	--	8
San Antonio	29 25	98 25	--	--	--	6	2	--	--	--	--	--	--	--	8
La Crosse	43 48	91 27	3	2	1	--	--	--	--	--	--	1	--	--	7
Halifax	44 40	63 35	--	1	--	--	1	--	--	1	1	*	*	*	4
Geneva	42 53	77 5	--	--	--	--	--	2	*	*	1	*	--	--	3
Omaha	41 16	96 0	--	--	1	--	1	--	--	--	--	*	*	*	2
Chicago	41 52	87 38	--	1	--	--	1	--	--	--	--	--	--	--	2
Leavenworth	39 19	94 58	--	--	--	1	--	--	--	--	--	--	--	--	1
St. Paul	44 53	93 5	--	--	1	--	--	--	--	--	--	--	--	--	1
Morgantown	39 40	79 55	*	--	1	--	--	--	--	--	--	*	*	*	1
Oswego	42 28	76 35	1	--	--	--	--	--	--	--	--	*	*	--	1

An asterisk shows that observations for the month indicated are wanting.

The number of stations at which a difference of 40° between the maximum and minimum of the same day was observed in

1873, is 16, which is 40 per cent of the whole number of stations; and among the stations at which so great a difference was *not* observed, are Kingston, Toronto and Montreal, in Canada, and the summit of Mount Washington in New Hampshire.

In the Report of the Chief Signal Officer for 1874 is given the maximum and minimum temperature of each day in 1874 at 107 stations in the United States and Canada. The following table shows all the cases in which the difference between the maximum and minimum of the same day amounted to at least 40°.

Diurnal Change of Temperature of 40° *and upwards in* 1874.

	Lat.	Lon.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	° ′	° ′													
Colorado Springs	38 55	104 58	8	3	4	3	11	9	8	--	--	*	2	8	56
Denver	39 44	105 4	2	1	1	4	6	6	4	1	8	7	4	1	45
Cheyenne	41 12	104 42	--	--	--	--	6	5	7	4	5	2	3	1	33
Fort Sully	44 39	100 40	5	1	2	4	1	--	1	--	5	3	2	--	24
Breckenridge	46 11	96 17	1	4	1	--	3	1	--	--	4	1	1	3	19
Yankton	42 45	97 30	4	1	--	2	--	--	--	--	4	3	1	--	15
Geneva	42 53	77 5	2	--	--	1	4	4	*	*	*	--	--	--	11
San Antonio	29 25	98 25	3	1	--	5	--	--	--	--	--	--	--	1	10
Pembina	49 0	97 5	--	1	1	--	3	--	--	--	2	1	1	--	9
Fort Garry	49 52	96 58	--	2	--	2	1	--	--	--	--	1	1	--	7
Stayner	44 25	80 15	1	--	--	1	3	1	--	--	--	*	--	--	6
Fort Gibson	35 43	95 16	1	--	--	--	--	--	--	--	--	1	2	1	5
Chatham	47 1	65 30	--	2	2	--	--	--	--	--	--	--	--	--	4
Halifax	44 40	63 35	--	1	1	--	--	--	--	--	--	--	--	1	3
La Crosse	43 48	91 23	--	2	--	--	1	--	--	--	--	--	--	--	3
Morgantown	39 36	79 52	--	--	--	1	--	--	--	--	--	2	--	--	3
Leavenworth	39 19	94 58	--	--	--	--	--	--	--	--	--	--	--	2	2
Mt. Washington	44 16	71 16	2	--	--	--	--	--	--	--	--	--	--	--	2
Ottawa	45 22	75 45	--	--	--	--	1	1	--	--	--	--	--	--	2
Sydney	46 18	60 9	--	--	1	--	1	--	--	--	--	*	--	--	2
Wytheville	36 56	81 0	*	*	*	*	--	--	--	1	1	*	*	*	2
Albany	42 40	73 45	--	--	--	--	1	--	--	--	--	*	*	--	1
Buffalo	42 53	78 55	--	1	--	--	--	--	--	--	--	--	--	--	1
Burlington	44 29	73 15	--	--	--	--	--	--	--	--	--	--	--	1	1
Charleston	32 45	79 55	--	--	--	--	--	--	--	1	--	*	*	--	1
Davenport	41 32	90 38	--	--	--	--	--	--	--	--	--	--	1	--	1
Duluth	46 48	92 8	*	*	*	*	1	--	--	--	--	*	*	*	1
Eastport	44 55	66 54	1	--	--	--	--	--	--	--	--	*	*	--	1
Erie	42 7	80 10	1	--	--	--	--	*	*	--	--	--	--	--	1
Kingston	44 12	75 41	--	--	--	--	--	--	--	--	--	--	--	1	1
New London	41 22	72 9	*	*	--	--	1	--	--	--	--	*	*	*	1
Norfolk	36 51	76 19	--	--	--	--	1	--	--	--	--	*	*	--	1
Omaha	41 16	96 0	1	--	--	--	--	--	--	--	--	--	--	--	1
Portland, Oreg.	46 30	122 27	*	*	*	*	*	1	--	--	--	*	*	*	1
Port Stanley	42 40	81 13	*	*	*	*	--	1	--	--	--	*	*	*	1
Saugeen	42 40	81 16	--	--	--	--	1	--	--	--	--	*	--	--	1
Squan Beach	40 8	74 1	*	*	--	--	--	--	--	--	--	*	*	1	1
Saint Louis	38 37	90 15	1	--	--	--	--	--	--	--	--	--	--	--	1

The number of stations at which a difference of 40° between the maximum and minimum of the same day was observed in 1874, is 38, which is 35 per cent of the whole number of stations; and among the stations at which so great a difference did *not* occur, are Kingston, Toronto and Montreal, in Canada, and Pike's Peak, at an elevation of 14,092 feet above the sea.

From the preceding tables it appears that throughout the greater part of the United States there is occasionally observed a difference of 40° between the maximum and minimum temperature of the same day, and there are a few places where such changes are remarkably frequent. This phenomenon occurs most frequently at stations situated between the Mississippi River and the Rocky Mountains, and at the head of the list stand Colorado Springs and Denver. Colorado Springs is situated on the eastern side of Pike's Peak, at an elevation of 5,935 feet above the sea, and Denver is distant from it about 60 miles on the eastern slope of the Rocky Mountains, at an elevation of 5,135 feet.

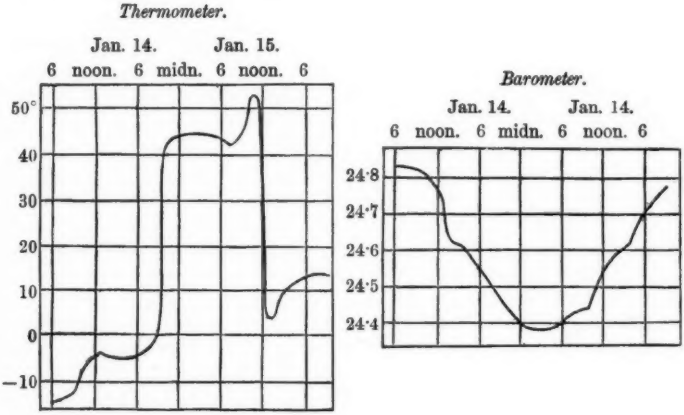
These cases of great diurnal change of temperature result from the ordinary diurnal change combined with the effect due to the passage of a great storm; and the sudden fall of temperature, which frequently succeeds a great storm, I think cannot be fully explained without admitting the sudden descent from a great height of air whose temperature is unusually low. The proximity to mountains appears to favor this sudden descent of air from a great height. Colorado Springs and Denver are situated where the upward and downward motion of atmospheric currents must be uncommonly frequent, and they surpass all the other stations of the signal service in the magnitude and suddenness of the changes of temperature. An instance of this kind has recently been reported which is the most remarkable I have ever known. I have received a statement of the facts from three different sources, all of which agree in the main, but they show differences of several degrees of temperature, which may be ascribed to a difference in the exposure of the instruments. The most moderate statement is that furnished by the observer at the U. S. signal service station, and I will therefore adopt his numbers in preference to either of the others.

Storm of Jan. 15, 1875, *at Denver, Colorado.*

On the 14th of January, 1875, the thermometer at Denver had been below zero all day, with a variable northeast wind. At 9 P. M. of that day the thermometer was one degree above zero. The wind then veered suddenly to southwest; and at 9.15 P. M. the thermometer stood at 20°; at 9.20 P. M. it stood

at 27°; at 9.30 P. M., 36°; and at 9.35 P. M. at 40°; after which there was but little change till near noon of the next day. The preceding observations show a rise of the thermometer amounting to 39 degrees in 35 minutes.

On the 15th of January, the thermometer had been above 40° all the morning, with a fresh southwest wind. About 11.30 A. M. the thermometer stood at 52°. The wind then suddenly backed to northeast, and at 12.30 P. M. the thermometer stood at 4°; being a change of 48° in one hour. Another observer, who is pronounced perfectly reliable, says that between 11 A. M. and noon a thermometer fell from 58° to 22° (that is, thirty-six degrees) in five minutes. The annexed figure on



the left will perhaps give a better idea of the extent and suddenness of these changes of temperature than would be derived from a simple description. The entire curve shows the state of the thermometer for nearly two days, from 5.43 A. M., Jan. 14th, to 9 P. M., Jan. 15th, according to the observations made at the signal service station. The figure on the right shows the changes in the pressure of the atmosphere during the same period. On the 14th the barometer fell from 24·83 to 24·40 inches, and on the 15th it rose again to 24·76 inches.

These changes of temperature and pressure which were noticed at Denver, were the effects of a considerable storm which came from the northwest, and whose center passed on the east side of Denver, within about 250 miles of that place. This storm was accompanied by high winds and gales in Colorado and Kansas. It probably did not differ materially from the winter storms frequently experienced in other portions of the United States, except in the extreme suddenness of the

changes of wind and temperature. I do not think that these sudden changes can be fully explained by the supposition of a polar current sweeping along the earth's surface from a higher to a lower latitude, but it seems necessary to admit a sudden transfer of very cold air from a higher to a lower level. The heat of Jan. 14th probably resulted from the sudden precipitation of vapor caused by the elevation of air from the earth's surface; and this warm air near the earth's surface suddenly ascended on the 15th, being displaced by the colder air of a greater elevation.

In preparing the materials for this article, I have been assisted by Mr. Edward S. Cowles, a graduate of Yale College of the class of 1873.

ART. II.—*Preliminary Note on a Magnetic Proof Plane;* by HENRY A. ROWLAND.

ABOUT four years ago I made a large number of experiments on the distribution of magnetism on iron and steel bars by means of a coil of wire sliding along the bar; the induced current in the coil as measured by a galvanometer was a measure of the number of lines of force cut by the coil and can be found in absolute measure by my method of using the earth inductor. These researches have never yet been published owing to circumstances beyond my control, but are known to quite a number of persons in this country, and will soon be published. The method there used is the only correct one that I know of for experimenting on magnetic distribution, and my purpose in this note is to extend it to bodies of all shapes, so that experiments on magnetic distribution may become as simple and easy to perform as those on electrical distribution. And so well has my magnetic proof plane accomplished this that I can illustrate the subject to my classes with the greatest ease.

The apparatus required is merely a small coil of wire $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter, containing from 10 to 50 turns, and a Thomson galvanometer. When we require to reduce to absolute measure, another coil about a foot in diameter and containing 20 or 30 turns is required. Having attached the small coil (or, as I call it, the magnetic proof plane) to the galvanometer, we have merely to lay it on the required spot, and when everything is ready, to pull it away suddenly and carry it to a distance, and the momentary deflection of the galvanometer needle will be proportional to that component of the lines of force at that point which is perpendicular to the plane of the coil. And if we apply it to the surface of a permanent magnet the so-called

surface density of the magnetism at that point will be nearly proportional to the deflection. In the case of an electro-magnet the surface density will be nearly proportional to the deflection minus the deflection which would be produced by the helix alone, though the last is generally small and may be neglected. I use the words *nearly* in the above statement because they are only exactly true in the cases where the lines of force proceed from the surface in a perpendicular direction; otherwise the deflections must be multiplied by the secant of the angle made by the lines of force with the surface of the magnet. In the case of an electro-magnet made of very soft iron, theory shows that the lines pass out nearly perpendicular to the surface and so no correction is needed.

We can also, by a coil of this kind, determine the intensity of the magnetic field at any point and thus be able to make a complete map of it. Having done this, we have all the data necessary to substitute in the formula which I have given in this Journal,* and by a simple experiment can thus determine the coefficient of magnetization of any diamagnetic or weak paramagnetic body probably in a more accurate manner than any Weber used. Only the largest-sized magnets could of course be used for this purpose with any accuracy, and indeed they are always to be preferred in obtaining the distribution by this method.

Having obtained the distribution for any given magnet, the distribution for any similar magnet of the same material but of different size becomes known by a well known law of Sir William Thomson.

As, in the present state of our knowledge, magnetic measurements are of small value unless made on the absolute scale, we require to reduce our results to this system. There are several methods of doing this, but the simplest is that which I have used in my experiments on magnetic permeability, and consists in including an earth inductor in the circuit. A coil laid on a perfectly level surface is sufficient for this: when this is turned over, the induced current will be equal to $C=\frac{2n\mathrm{V}\mathrm{A}}{\mathrm{R}}$, where n is the number of turns in the coil, A its mean area, V the vertical component of the earth's magnetism, and R the resistance of the circuit. When the small coil is pulled suddenly away the current will be $C'=\frac{n'\mathrm{Q}a}{\mathrm{R}}$, and so we have $\mathrm{Q}=2\mathrm{V}\frac{\mathrm{A}n\mathrm{C}'}{an'\mathrm{C}}$, in which when a Thomson galvanometer is used C′ and C can be replaced by the corresponding deflections; hence $\mathrm{Q}=2\mathrm{V}\frac{\mathrm{A}n\mathrm{D}'}{an'\mathrm{D}}$, in which a and n' are the area and number of turns in the small

* On a new diamagnetic attachment to the lantern, &c., this Journal, May, 1875.

coil and Q is that component of the magnetic field we are measuring in the direction of the axis of the small coil.

As an illustration of this method I will give a few experiments made with the magnets of a Ruhmkorff diamagnetic apparatus, which was altogether about 2 ft. long and had its magnets 2 in. in diameter, with a hole ½ in. in diameter through them for experiments on the rotation of the plane of polarization of light, but which in these experiments were closed by the solid poles which were screwed on. The first experiments were with two discs of iron, 4·6 in. in diameter and 1⅜ in. thick, screwed on to the poles. In the first place the poles were turned away from one another, the current being sent through only one magnet, and the values of the magnetic field obtained at different points close to the surface of the disc. These may be numbered as follows: No. 1, at center of face of disc; No. 2, on face of disc half an inch from the edge; No. 3, on center of edge of disc. The measures are on the meter, gram, second system.

1st. Strength of current, 4·4 farads per second.

1. 2220. 2. 3550. 3. 4440.

2nd. Strength of current 8·3 farads per second.

1. 3600. 2. 5300. 3. 7500.

Next the poles were turned toward each other and the current sent through both magnets, so as to make the poles of the same name. Current 4·6 farads per second.

1st. Distance of poles, 3 in.

1. 1300. 3 3800.

2nd. Distance of poles, 1½ in.

1. 600. 3. 4000.

Here we see an approach to one of Faraday's places of no magnetic action.

After this the current in one of the magnets was reversed so as to make the poles opposite. Current the same.

1st. Distance of poles, 3 in.

1. 5800. 2. 8200. 3. 6700.

2nd. Distance of poles, 1½ in.

1. 9800. 2. 7500. 3. 5800.

It is curious to note how the distribution changes with the distance of the discs; thus, on one disc free from the other, the edge of the disc has the greatest magnetic surface density, but when the two discs form opposite poles and are 3 in. apart, position 2 gives the greatest effect, while, when they are 1½ in. apart, the field is greatest at the center. This entirely agrees with theory.

The conical poles for diamagnetic experiments were then screwed on. These were portions of cones with an angle at vertex of about 60°, with the vertex considerably rounded off. They were one inch apart and the poles were opposite. Current 4·4 farads per second.

At center of field between the poles,	12500
On the axis near one pole,	32100
On cone one inch from vertex,	11000
On cylindrical portion of magnet 2½ inches from the vertex of the cone,	5800

These poles were now replaced by frustums of cones with flat ends, the original diameter of the iron, 2 inches, being reduced at the end to 1½ inches, and they were placed ¼ inch apart. The field in this case between them was 61000, or nearly up to the maximum of magnetization of nickel at common temperatures, and above that at high temperatures.

Troy, April 1, 1875.

ART. III.—*On Pseudomorphs of Chlorite after Garnet at the Spurr Mountain Iron Mine, Lake Superior;* by RAPHAEL PUMPELLY. With Plate II.

PSEUDOMORPHS of garnet occur in abundance in a bed of chloritic schist, just overlying the great magnetite bed of the Spurr-Michigamme iron range.*

This schist is of Archæan age and belongs in the upper beds of the Huronian iron series. It is a very fine-grained, dark green chlorite, which gives a light green streak and powder, dissolves in acids leaving a deposit of silica, and fuses B.B. on the edge to a black magnetic enamel (fus. = 4.) It is impregnated with octahedrons of magnetite, which rarely reach a diameter of one-eighth inch. Throughout the rock are scattered the pseudomorphs in very sharply defined rhombic-dodecahedrons of all sizes below 1½ inches in diameter. Often perfect crystals can be easily detached from the matrix.

On breaking the crystals and polishing the surface of fracture, they are found to be changed more or less to chlorite, in some instances specimens an inch in size containing not more than five per cent of garnet, while in others 30–50 per cent of unaltered mineral is present.

The octahedral crystals of magnetite are scattered through the pseudomorphs. They are visible to the naked eye, half

* I am indebted to Dr. Cobb, the agent of the mine, and to Col. F. Norvell, general manager, for several hundred fine specimens of these pseudomorphs.

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imbedded on the surface planes, and in the interior of the crystals, both in the chlorite and in the unaltered garnet.

I have made several thin sections passing through the middle of crystals, about one inch in diameter, and have studied them under the microscope, making such examination of the optical characteristics as the nature of the minerals and the limitations of the method would permit.

Under a one-tenth inch objective (500 diameters) the garnet appears not to be strictly homogeneous in texture; it has a curdled structure, particles of a transparent bluish-white filling the irregular meshes of a less clear, white net-work. Both of these portions of the garnet are isotrope, remaining dark through a full revolution between crossed nicols. Throughout both of these members are scattered exceedingly minute particles of a transparent red substance (hematite?) and larger opaque grains and discoidal plates.

A glance at a section under a low power shows that the change has taken place by an attack on the garnet along the countless fissures that traverse it in every direction (fig. 1), progressing most rapidly in the larger cracks, and ramifying through the more minute ones.

Two substances, one greenish-yellow, the other clear green, seem at first sight to be among the products now forming the pseudomorphs, though, as we shall see, they both probably belong to the same mineral.

I. The slightly greenish-yellow mineral (fig. 1) surrounds the remaining garnet fragments in bands which are in places clear and transparent, and in others are marked with longitudinal wavy lines, which probably indicate the cleavage of the mineral. From these broader bands, narrow ones branch off to form an intricate net-work in the garnet fragments. The same mineral occurs in isolated and grouped, long and slender crystals, which often branch out from or intersect the bands; while in other places the bands are often made up of these crystals, arranged more or less parallel to each other.

These bands are generally $\frac{1}{1000}$ to $\frac{1}{100}$ of an inch wide, and under a low power (figs. 1 and 2) their edges are sharply defined. Where a garnet fragment has been entirely destroyed, its place is occupied by an interwoven mass of them, often associated with irregular patches of the green substance described below. Under a high power, both the transparent red particles and the opaque grains and plates that were noticed in the garnet, are observed in this alteration-product.

These bands, when observed with only one nicol—the polarizer—show a high degree of absorption for intensity, and an appreciable amount for color, changing from very dark (with bluish-green tint), when the longer direction is

parallel to the undulation plane of the nicol, to very light (with greenish-yellow tint) when perpendicular to that plane. Assuming that the parallel sides of the bands are crystallographic outlines and that they lie either in the basal plane, or else parallel to the principal crystallographic axis, I have attempted to determine optically the system to which these crystals belong. The method followed is that recommended by Tschermak in distinguishing pyroxene, hypersthene and biotite. Having carefully adjusted the microscope,* so that the cross hairs in the ocular coincided exactly with the undulation planes of the crossed nicols, I first selected an individual, generally a long one with straight sides, and brought it by means of one of the cross-hairs into parallelism with the undulation plane of one of the nicols, and then revolved the stage till the nearest point of maximum darkness was reached, when the principal sections of the crystal coincided each with a principal section of a nicol's prism. The number of degrees of this revolution indicate the inclination of the principal sections of the crystal to the crystallographic feature chosen for reference.

Of course, if the mineral were either uniaxial or orthorhombic, the maximum of darkness would occur when two of the axes of the crystal were parallel to the undulation planes of the nicols, and there would be no revolution required. But this could occur in a monoclinic crystal only when one of the principal sections happened to coincide with the plane of symmetry; in every other position the axes of the crystal would make with its principal sections an angle which would vary between 0° and the number of degrees representing the inclination of the bisectrices to the vertical and inclined lateral axes; the full amount of this inclination could only be observed when the principal sections of the crystal were perpendicular to the plane of symmetry, but any inclination suffices to determine that the crystal belongs to a clinobasic system. Observations on a great number of the bands and isolated crystals failed to show any inclination; the mineral, therefore, does not belong to a clinobasic system.

II. The clear green portions occur isolated in the garnet fragments, and in places in the fissures with the mineral last described, and more or less diffused through the larger bands, but more generally in irregularly-shaped spots, and with outlines which are not necessarily determined by those of the garnet fragments. These larger areas exhibit lamellar aggregate polarization both between crossed nicols and with the polarizer alone. Between crossed nicols portions remain

* One of Beck's first class binoculars, in which the polarizer is attached to a sub-stage, and the main stage is graduated.

wholly dark during a revolution, some show only a faint change, and others are not distinguishable from the substance forming the bands, except that the cleavage lines are not so distinct. So also with one nicol, the portions that remain dark between crossed nicols show no absorption, while other portions change from clear green to almost colorless faint green-yellow, and still others show about the same changes as the bands.

Again, we find in places, on the same individual, all these conditions, shading gradually one into the other in a manner that seems to indicate a bent crystal. I am inclined to look upon the bands and the clear green as identical, and as belonging to a hexagonal chlorite. The green portions would then be those which were cut more or less parallel to the basal plane, and the dichroitic bands those cut perpendicular to this.

While the plane of contact between the chlorite bands and garnet appears sharp under a low power, higher objectives (one-tenth or one-sixteenth inch) show it to have a rough surface caused by the projection of countless chlorite points into the garnet substance, in a manner that leaves on the observer the impression that the attack is facilitated in some way by the curdled structure of the garnet.

The chloritic schist which encloses the pseudomorphs consists apparently of exactly the same chlorite, the only perceptible difference being that in the schist the individuals are very minute, averaging ·00015 inch thick by ·0005 long, with scattering aggregations of crystals ·0008 by ·004 inch.

The optical characteristics of these larger, and so far as determinable, of the smaller, are identical with those of the chlorite in the pseudomorph.

The only other substances observed in the schist are minute octahedrons of magnetite and the discoidal plates which occur indifferently throughout the schist, the garnet substance, and the pseudomorphous chlorite. These plates average about ·00025 inch thick by ·00075 in diameter, and in reflected light have metallic luster. They are not attracted by the magnet and show no change after continued boiling in sulphuric and in muriatic acids. I had at one time the impression that they were graphite, but on comparing them with microscopic plates of that mineral in the Port Henry limestone, the difference in luster and fracture appeared very great.

These minute plates appear to me to be older than either the garnet or the chlorite—to have been enclosed in the original rock (argillaceous limestone ?), and to have resisted the changes which successively produced the garnets and destroyed these and substituted chlorite for them and the original rock.

If this view is correct, the paragenesis should be as follows:

I. Original Rock (*Marl ?*)

II. METAMORPHIC CHANGE with crystallization of
(*a.*) Octahedrons of *magnetite* and the *discoidal crystals.*
(*b.*) Garnets.

III. PSEUDOMORPHIC CHANGE. *Chlorite* after the original rock and after garnet, but preserving the magnetite and discoidal crystals intact.

ART. IV.—*Brief Contributions from the Physical Laboratory of Harvard College.* No. 18.—*An Application of the Horizontal Pendulum;* by HARCOURT AMORY.

THE paper on the horizontal pendulum published by Zöllner, in Poggendorf's Annalen, suggested the following application of the instrument to proving Ampère's laws of the attraction and repulsion of currents. To prove these laws, the circuit which the current traverses must consist of two parts, one fixed and the other movable. The apparatus devised by Ampère is difficult to make. By the use of the horizontal pendulum, however, the mutual action of the currents can be readily shown. The apparatus is arranged as in the accompanying

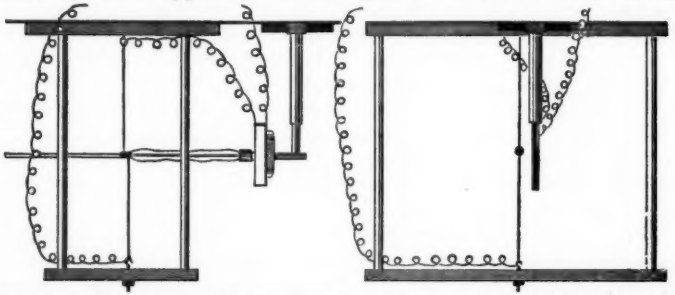


figure. The wire which forms the upper support of the pendulum is connected with one pole of a battery, and is then led along the horizontal bar of the pendulum, best made of glass, and is bent in the form of a parallelogram at the extremity of the bar. The wire is then led back to form the lower support of the pendulum, and is then connected with the other pole of the battery through a fixed coil of wire placed in the neighborhood of the end of the pendulum.

The current first passes to the upper suspending wire, around the parallelogram at the extremity of the pendulum, back through the lower supporting wire, through the outside coil, and returns to the battery. By turning the outside coil upon a horizontal axis, the laws of attraction or repulsion of rectilinear currents can be shown. The apparatus is peculiarly well adapted to show the action of solenoids upon each other.

ART. V.—*Explosive Properties of Methyl Nitrate;* by M. CAREY LEA, Philadelphia.

SEVERAL dangerous accidents have recently occurred in the manufacture of methyl nitrate, one of them unfortunately resulting in the death of Mr. Chapman. This, and the remarks recently published on the subject by M. Girard, the well known French chemist (an abstract of which lately appeared in the pages of this Journal), leads me to make a few observations on this subject.

When I first attempted to prepare this substance by the only method published up to that time, I felt convinced that the chances were greatly in favor of an accident, though no warning was given in the text books. I therefore wore a mask, and operated cautiously with moderate quantities in a very large flask. A tremendous explosion followed, in which the flask entirely disappeared; no fragment of the body could be found. I then tried the use of urea in the same modified manner which I had proposed in the case of ethyl nitrate. The operation was entirely successful, and was many times repeated without any trouble or difficulty. And it is, I presume, in this way that it is now commercially manufactured on a large scale.

Within the last few days I have made the following experiments on its explosive properties.

Contrary to what has been stated, I do not find it liable to explode by percussion. Some extra thick filtering paper was saturated with it, was placed on a piece of iron, and forcibly struck with a hammer. This was repeated a dozen times, until the paper was broken to pieces, without explosion.

Five or six drops were placed in a test tube; this was placed in a deep cup, and a little alcohol poured into the cup and inflamed. In this way the flames played chiefly on the surface of the test tube above the liquid, thus preventing its escape by evaporation at low temperatures. A slight explosion followed, which did not break the test tube.

When ethyl nitrate was similarly treated, it quickly evaporated without explosion.

Twenty measured minims of methyl nitrate were then placed in the tube, and the experiment repeated. A moderate explosion followed, breaking the tube.

The same quantity as in the first experiment, five or six drops, was placed in the test tube, and dry sand added more than enough to absorb the liquid. The heat was applied in the same way as before, but the explosion was not greater than without the sand, except that the tube was broken.

When poured on filtering paper and inflamed, it burns quietly with a peculiar livid flame.

These trials do not seem to indicate a very violent explosive power. Nevertheless, the unfortunate experience which has been already gained sufficiently indicates that it is not a substance to trifle with. Indeed, a liquid whose vapor explodes at 150° C., as determined by Dumas and Peligot, cannot be otherwise than dangerous, especially when handled in large quantity. Having been the first person to prepare this substance in any quantity, and having had occasion to study carefully its conversion into the methyl ammonias, it occurs to me that as these substituted methyl compounds are now used on a large scale, a few suggestions toward a safe method of managing the operation for large quantities may be acceptable.

I would propose to construct a receptacle in which to receive the methyl nitrate vapors as they are distilled over, of the shape shown in the margin, a cylindrical vessel with a large mouth and two faucets, one near the bottom, the other a little above the middle.

To commence the operation, the vessel should be filled one-third full with lumps of ice. The cover should then be closely fitted on with a safety tube, and a third tube connecting with another similar vessel.

As the partly condensed mixed alcoholic and ethereal vapors come over, the products of distillation are cooled by the ice, and the water resulting from its melting precipitates the ether. This last can be from time to time drawn off by the lower faucet, into stoneware bottles already containing a proper quantity of strong ammonia and alcohol. When one-third full of the ingredients in the proper proportions, these bottles should be securely closed, and placed for several days at a temperature of about 90° F., until decomposition is complete.

The upper faucet shown in the cut is to draw off the mixed water and alcoholic distillate which accumulates in large quantities over the ether, and which otherwise would impede the operation.

In the process as above described, the methyl nitrate would be destroyed almost as soon as formed. As soon as any considerable quantity has passed over, it could be transferred into the vessels in which, by contact with ammonia, decomposition begins, and this without interrupting the distillation. If desired, sodium carbonate can be placed in the condensing vessel to remove any nitric acid that may adhere to the methyl nitrate. But the presence of a little acid is not important in the decomposing jar; it would be converted into ammonium nitrate, and as this salt is always formed to some extent by the action of

methyl nitrate on ammonia, the presence of a fraction more or less would be unimportant.

I am inclined to believe that in the manner described, the danger in the preparation of this substance will be reduced to a minimum, a matter of some importance, as the quantity consumed in the manufacture of the methyl violet seems likely to be increasingly large. A good cooling apparatus between the retort or still and the receiver here figured would be necessary.

W. Weith has just published* an interesting communication on the formation of methyl-ammonias by the action of excess of methyl alcohol on sal ammoniac, which at 285° C. was completely converted into methyl ammonias. This method of methylizing ammonia may perhaps take the place of mine: it is, however, liable to two objections; first, that a considerable proportion of the methylic alcohol is, according to Herr Weith, lost by conversion into methyl ether; secondly, the high temperature and pressure necessary. I found that methyl nitrate, unlike ethyl nitrate, does not require pressure vessels, but reacts at or near the ordinary temperature and pressure. My own operations were performed in large stoppered vials set on the cooler part of a sand bath, where the temperature did not rise above 90°. The loss by formation of methyl ether may perhaps be compensated by the fact that in the formation of methyl nitrate there is always loss of both methylic alcohol and nitric acid.

Philadelphia, May 17, 1875.

ART. VI.—*Contributions from the Sheffield Laboratory of Yale College.* No. XXXIV.—*On Zonochlorite and Chlorastrolite;* by GEORGE W. HAWES.

AT the meeting of the American Association for the Advancement of Science which was held at Dubuque, Iowa, in 1872, Prof. A. E. Foote described "a new hydrous silicate" found at Neepigon Bay, on the north shore of Lake Superior.† It is a hard, green mineral occurring in the amygdaloidal trap, associated with calcite, quartz, and various zeolites; and it is also found in the form of smooth water-worn pebbles upon the shore. This mineral, on account of its structure, he called *Zonochlorite*, since many of the specimens are beautifully banded; and his analysis convinced him that it was a zeolite. The stones which he regarded as pure were of a uniform dark green color; while

* Bericht Deut. Chem. Ges., 26th Ap., 1875.

† Proceedings of the American Association for the Advancement of Science, 21st meeting, August, 1872, p. 65.

those which were very plainly banded with white he considered impure. But thin sections of some of the dark green stones, received from Prof. Foote, and considered by him as the purest zonochlorite, when examined under the microscope, show that these, like the other specimens, are more or less banded and consist of green earthy particles disseminated through a white mineral. A dark green specimen gave me, on analysis, the following composition:

Silica	35·94
Alumina	19·41
Ferric oxide	6·80
Ferrous oxide	4·54
Lime	22·77
Magnesia	2·48
Soda	*trace*
Water	8·40
	100·34

The analysis indicates that the mineral is a very impure variety of prehnite, a mineral which is common in the trap of that region; and its hardness and behavior before the blowpipe point to the same conclusion. The analytical results obtained by Prof. Foote show that the material he examined was not homogeneous, as he states that the percentage of water, the average of which was 8·7, varied from 7·03 to 12·9. The presence of magnesia shows that a portion of the impurity is chlorite.

Zonochlorite in its mode of occurrence resembles *Chlorastrolite*,* which is found on the shores of Isle Royale in rounded pebbles derived from the amygdaloidal trap, and has also been found *in place* in the trap. At the suggestion of Prof. Brush, who placed at my disposal the specimens which were brought by him from Lake Superior, thin sections were made from some of the best stones in his possession: and the microscopic examination of these made it very evident that chlorastrolite is not a homogeneous substance—the impurities in this case being distributed through a white mineral of a radiated structure; and to the irregular arrangement of the pure and impure material the stone owes its beauty. When a flat surface is cut upon one of these stones, the polished face presents various shades of green; but when the other side is cut away, thus making a thin section of the stone, those spots which have the deepest green are found to be perfectly clear and white, receiving their deep green shade from the colored surfaces beneath. The green

* Boston Journal of Natural History, vol. v, p. 488. Report on the Geology of the Lake Superior Land District, Part II, p. 97. Dana's Mineralogy, 5th edition, p. 412.

impurities are arranged along lines radiating from these clear centers, till at some distance the mixture becomes so intimate as to appear nearly homogeneous until more highly magnified. An analysis of a very fine stone gave the following result:

	I.	II.
Silica	37·41	
Alumina	24·62	
Ferric oxide	2·21	
Ferrous oxide	1·81	
Lime	22·20	
Magnesia	3·46	
Soda	·34	·30
Water	7·72	
	99·77	

The essential difference between this analysis and those by Prof. J. D. Whitney is, that the percentages of magnesia and soda have exchanged places, since he obtained no magnesia and 4 per cent. of soda. For this reason, I repeated my alkali determination upon another sample prepared from portions of several stones, but with no variation in the result, as will be seen in No. II above. This great difference can be accounted for in no way save by the evidence, which the microscopic examination affords, that the stones are mixtures of minerals which have been carried into the amygdaloidal cavities of the trap. The stones that I have seen appear to consist, like the zonochlorite, largely of impure prehnite. The higher specific gravity may be due to an enclosure of epidote, which is everywhere associated with the chlorastrolite in the rocks, and moreover is often present in the same cavity.

ART. VII.—*Contributions from the Sheffield Laboratory of Yale College.* No. XXXV.—*On Glycogen and Glycocoll in the Muscular Tissue of Pecten irradians;* by R. H. CHITTENDEN, Assistant in Physiological Chemistry.

THE genus Pecten is world-wide in its distribution. The species *irradians* is entirely American, being found most abundantly on the eastern shores of the United States. It is closely allied to the European and English species *opercularis* and *maximus*. The large central muscle which closes the valves of this mollusk is highly valued as an article of food, although its peculiar sweet taste is objectionable to some.

With this central muscle the following experiments were made:

Glycogen.—By extracting the edible portion of the scollop with cold water, a milky opaque fluid with slight acid reaction is obtained, and an insoluble residue consisting principally of syntonin or fibrin mixed with inorganic matters. The strong opacity of the aqueous solution is not due to an emulsion of fatty matters. On boiling the solution with or without the addition of acetic acid, a large amount of albumin is precipitated, leaving the fluid still opalescent On treating the fluid, after the removal of albumin, with a small amount of ninety-five per cent alcohol, a light flocculent precipitate is obtained which dissolves by agitation, leaving the fluid unaltered in appearance; but if three or four volumes of the alcohol are added, a copious, permanent precipitate settles, leaving the supernatant fluid perfectly clear. This precipitate is of snowy whiteness, except when previous to precipitation the fluid has been boiled considerably, in which case both filtrate and precipitate assume a yellow or brownish color, from which the latter can be freed by solution in cold water and reprecipitation by alcohol. The precipitate, if allowed to dry in contact with air, after having been washed with alcohol merely, soon becomes translucent on the edges and finally is transformed completely into a gummy mass, which is sticky when moistened; but if after precipitation it is washed with ether thoroughly, it loses this property of becoming gummy, which seems to be due to the presence of water and of albuminous matters in small quantity. This gum-like mass when hard is brittle and yields on trituration a white hygroscopic powder showing under the microscope no distinct structure. A portion of the precipitate so prepared, dried in the air, yielded by analysis:

	1.	2.	Calculated. $C_6H_{10}O_5 + H^2O$ or $C_6H_{12}O_6$
C	39·52	39·56	40·00
H	6·62	6·55	6·60
O	53·86	53·89	53·34

In this state it is not quite pure, giving with Millon's reagent a strong reaction for albumin and containing some inorganic matter, one specimen 1·57 per cent, another 1·38 per cent, consisting in all cases, so far as were examined, of calcium phosphate. From this analysis it is seen that the substance has the formula of the sugars, or that of the starch group plus a molecule of water. The substance is tasteless, gummy when moistened and gives an opaque fluid with water, seemingly a true solution, which passes unchanged through filter paper and animal charcoal, and shows no particles under the microscope with a half inch objective. When this aqueous solution is boiled, thin films separate, forming a scum on the top of the fluid, which goes into solution again as the liquid becomes cool.

The substance is insoluble in alcohol and ether, has no reducing action with cupric sulphate and sodium hydroxide, but when boiled with a few drops of dilute hydrochloric acid gives a clear fluid which has strong reducing action. This same reaction takes place also with nitric and sulphuric acids, but not so readily as with the former. A portion of the substance was treated with a small quantity of saliva at the ordinary temperature, and at 40° C., and in both cases the ptyalin acted immediately upon it and sugar was formed. Treated with a solution of iodine in potassium iodide, a brownish red or maroon color was obtained. These and other reactions pointed to glycogen. It was yet to be ascertained whether the sugar formed by the action of acids and ferments was glucose, also to examine the action of boiling dilute nitric acid upon it, and to determine whether the different formulæ of glycogen could be obtained by drying it at different temperatures. A portion of the substance was then boiled with hydrochloric acid until alcohol produced no precipitate in a sample tested, the excess of acid removed by oxide of silver and the sugar obtained by evaporation. The product had all the properties of glucose, was intensely sweet, reduced alkaline solutions of copper and silver and yielded Pettenkofer's reaction. Analyzed, it gave the following result:

	1.	2.	Calculated. $C_6H_{12}O_6 + H_2O$
C	36·15	36·17	36·36
H	6·82	6·88	7·07
O	57·03	56·59	56·57

By the action of boiling dilute nitric acid, oxalic acid was formed and separated. A different sample of the original substance, dried over sulphuric acid until a constant weight was obtained, yielded:

	1.	2.
C	43·81	43·90
H	6·43	6·46
O	49·76	49·64

A sample dried at 100° C. gave by analysis:

	1.	2.	Analysis of starch dried at 100° C. by Mulder
C	43·86	43·89	43·86
H	6·41	6·38	6·28
O	49·73	49·73	

A sample dried at 140° C.:

	1.	2.	Analysis of starch dried at 140° by Mulder
C	44·32	44·40	44·47
H	6·38	6·41	6·28
O	49·30	49·19	

On treating an aqueous solution of the substance at the ordinary temperature with an excess of a saturated solution of

barium hydroxide, a heavy white precipitate was obtained, soluble in water, insoluble in baryta water and alcohol. This precipitate was dissolved in water, the baryta removed by a little dilute sulphuric acid in the cold and then reprecipitated by an excess of alcohol.

Prepared thus, it seemed to have lost the property of becoming gummy so readily as before, and on examination was found to be completely free from albuminous matters, giving no reaction even with Millon's reagent and also contained only 0·61 per cent of ash. The substance dried at 100° C. gave by analysis the following result, agreeing closely with that of the preceding preparation dried at the same temperature:

	1.	2.
C	43·93	43·91
H	6·45	6·40
O	49·62	49·69

Another sample, prepared in the same way and dried between 110°–120° C., gave:

	1.	2.
C	43·56	43·63
H	6·71	6·71
O	49·73	49·66

Casting a backward glance, we see that the analysis of the air-dried substance corresponds with the formula $C_6H_{12}O_6$, that of the substance dried at 140° C. with $C_6H_{10}O_5$, which requires 44·44 C. 6·11 H. These results agree with glycogen, which in different states of hydration has been found to have the formulæ $C_6H_{10}O_5$, $C_6H_{12}O_6$ and $C_6H_{14}O_7$. But the results obtained by the analyses of the substance dried at 100° C. and 110°–120° C. do not agree closely with any of the above formulæ. The same is true of members of the starch group to which glycogen is closely related, and lately Dr. Nägeli * has published a paper in which he points out that the elementary composition of starch, dextrin and "amylo-dextrin" dried at temperatures not exceeding 116°, agrees better with the formula $C_{36}H_{62}O_{31}$, which requires 43·63 C. 6·3 H, than with $C_6H_{10}O_5$, and that after exposure to a temperature of 140 C., when the composition corresponds to $C_6H_{10}O_5$, we probably do not deal with undecomposed starch. The analysis of amylo-dextrin by Nägeli (loc. cit. p. 35), dried in a stream of hydrogen, at a temperature of 112° to 116° C, gave the following result:

	1.	2
C	43·58	43·85
H	6·86	6·58

* Beiträge zur näheren Kenntniss der Stärke Gruppe. Dr. Walter Nägeli. 1874.

A sample of dextrin dried at the same temperature gave Nägeli as a mean of two analyses, C. 43·52. H. 6·78, in both cases agreeing closely with my analyses of glycogen dried at 110°–120° C. Thus this substance, which is without doubt glycogen, coincides in this respect with its neighbors, dextrin, amylo-dextrin, etc.

A sample of glycogen, prepared by the preceding methods and dissolved in water, on treatment with basic lead acetate, with the application of a gentle heat, yielded a heavy gelatinous precipitate, which, when filtered off by the aid of a pump and washed with water, was found to contain lead. Dried at 100° C, it gave by analysis the following result:

	1.	2.
C	21·62	21·78
H	2·91	2·96
Pb	48·39	48·34
O	27·08	26·92

Since this result was obtained, I find that M. Bizio * has already discovered glycogen in some invertebrates. Among the Mollusks, he found it in considerable quantity in the oyster.

With glycogen from these sources he prepared a lead compound by means of tribasic acetate of lead, and says its "analysis has given me the formula $C_{12}H_{18}PbO_{10}$," which requires:

C	27·22
H	3·40
Pb	39·13
O	30·24

It will be seen at once that my result does not agree with this formula. I therefore made some further lead precipitates from the same and other preparations of glycogen, and in these simply determined the lead as follows:

Pb.	1st Prep.	2d Prep.	3d Prep.	4th Prep.
No. 1.	48·39	53·63	51·45	50·27
No. 2.	48·34	53·58	51·45	50·28

Some glycogen was also prepared from the liver of an ox by the usual method and dried at 100°. It yielded by analysis:

	1.	2.	Calculated. $C_{12}H_{22}O_{11}$
C	41·87	41·90	42·11
H	6·35	6·38	6·43
O	51·78	51·72	51·46

A lead preparation made from this gave:

	1.	2.
Pb	61·99	61·94

* Comptes Rendus, lxx, 175. Zeitschrift für Chemie, 1867, 745.

These results indicate that the composition of the precipitate is not constant.

The amount of glycogen occurring in this muscular portion of the scollop is quite large; at one time, from three quarts 160 grams were obtained; at another, two quarts yielded 70 grams.

Glycocoll.—On evaporating the alcoholic filtrate from the precipitated glycogen until quite concentrated and adding neutral lead acetate, a heavy white precipitate is produced, which is a combination of inorganic matters with the lead. The excess of lead is then removed from the filtrate by hydrogen sulphide, and after concentration the liquid is decolorized by animal charcoal. On further evaporation the fluid deposits white prismatic crystals. The crystals have a sweet taste, but upon ignition with soda lime, ammonia is evolved, evincing the presence of nitrogen, which at once separates it from the saccharine group. The crystals first obtained were not quite pure, but after treatment with animal charcoal and recrystallization gave by analysis a result corresponding to the composition of glycocoll. Two more distinct preparations were made and gave by analysis:

	1st Prep.		2d Prep.	3d Prep.	Calculated.
	1.	2.			$C_2H_3O_2NH_2$.
C	31·98	31·99	32·09	31·97	32·00
H	6·88	6·84	6·79	6·81	6·66
N	18·57	18·58	18·49	18·45	18·66
O	42·57	42·59	42·63	42·67	42·66

The impurities which seemed to be the most difficult to remove were coloring and inorganic matters. The crystals were soluble in water and weak alcohol, insoluble in ether and absolute alcohol. An aqueous solution, when treated with sulphate of copper and sodium hydroxide, assumed an azure blue color without separation of cuprous oxide on heating. The substance melted at about 180° C, then decomposed. With nitric acid fine crystals corresponding to nitrate of glycocoll were obtained. These analyses and reactions identify the substance as glycocoll, which I believe has never before been found in nature.*

A preparation was now made in which the alcoholic filtrate from the precipitated glycogen was evaporated without the addition of any reagents, and here the same crystals were obtained mixed with a considerable quantity of inorganic matters and some dextrose.

The amount of glycocoll occurring in the tissue is small, although where two or three quarts of material are used a fine crop of crystals may be obtained.

* Lehrbuch der Physiologischen Chemie, Gorup-Besanez, page 236. 1875.

The quantitative analysis of the edible or muscular portion of the scollop, as obtained at the market, is as follows:

1ST ANALYSIS.

	1.	2.
Water,	79·60	79·66
Solids,	20·40	20·34
Ash,	1·26	1·26
Nitrogenous matters (=N×6·4),	15·68	15·68
Ether extract,	·33	·28
Non-nitrog. by difference,	3·13	3·12

2D ANALYSIS.

	1.	2.
Water,	80·25	80·25
Solids,	19·75	19·75
Ash,	1·24	1·22
Nitrogenous matters,	15·04	15·04
Fatty "	·32	·24
Non-nitrog. "	3·15	3·25

Total amount of nitrogen in the substance dried at 100° C.:

	1.	2.
N	11·35	11·37

The percentage of glycogen was determined in two separate quantities.

	1.		2.	
	1.	2.	1.	2.
Glycogen,	2·43	2·40	1·98	2·19

The percentage of glycocoll was determined, but owing to the inaccuracy of the method, can be considered only as an approximation to the truth.

	1.	2.	3.	4.
Glycocoll,	·46	·68	·71	·39

The ash of the muscle consisted of the bases, soda, potash, magnesia and lime; acids, chlorine, sulphuric and phosphoric.

In conclusion, I wish to express my obligations to Prof. S. W. Johnson for advice freely given.

ART. VIII.—*Dr. Koch and the Missouri Mastodon;* by EDMUND ANDREWS, M.D., Professor of Surgery in the Chicago Medical College.

THE recent article of Professor Dana on the credibility of Dr. Koch's statement respecting the occurrence of human remains with those of the Mastodon in Missouri is a timely contribu-

tion, for many scientific men still quote Koch's testimony, as though it had never been impeached. The following facts were laid before the Chicago Academy of Sciences by Professor P. Hoy of Racine, Wisconsin, a well known scientist, and one whose honor and truth are above every shade of suspicion.

Many years ago, Professor Hoy visited the spot from which Dr. Koch had exhumed the skeleton now in the British Museum. He found the men who assisted him at the work and took their account of it. He himself also excavated and recovered some fragments of the skeleton missed by Dr. Koch.

It will be remembered (see Professor Dana's article on Dr. Koch's pamphlets) that the discoverer of this skeleton claims to have found it overlaid by one stratum of alluvium, one of marl, three of clay, and three of conglomerate, amounting to some fourteen feet of deposits above the bones. Professor Hoy states that this whole list of strata is a pure fiction. The skeleton was found close to the surface, with nothing but the surface muck over it. The men who assisted at the exhumation also informed Dr. Hoy that Dr. Koch did not drain the spot, as might have been done without great difficulty, but that he and they simply dug out the muck and earth, often working up to their waists in the water, and groping with their hands at the bottom to find the bones. In these circumstances it is obvious, aside from the question of veracity, that no accurate determination could have been made between flint weapons of later date and those which might be contemporaneous with the animal.

There seems no *à priori* improbability in the idea that the mastodon may have survived until after the advent of man upon this continent, but it is evident that Dr. Koch's testimony contributes nothing to the solution of that question.

The following fact may throw light on the burnt skeleton in Gasconade County, without impeaching Dr. Koch's testimony as to the scorched condition of those bones. The Western States are much more subject to long droughts than the Atlantic States or European countries. Here it is a common thing, in very dry seasons, for a peat-bed to be accidentally set on fire and completely burned up. In these cases all the bones in it are scorched, trees growing on it are undermined, and fall over, and any stone implements, or other incombustible objects lying on the surface sink down among the more ancient relics below. Afterward, the peat grows again, covering them all up; or sometimes the freshets of neighboring streams fill the hollow with clay and other river detritus. The skeleton in Gasconade County may have been scorched in this way, and

stones and arrowheads of a later age mingled with the bones. In examining the relics found in western swamps, it is always necessary to guard against the possibility of error introduced by the action of fires of this character.

No. 6, 16th street, Chicago.

ART. IX.—*Rate of Growth of Corals.* From a letter to Professor J. D. DANA, by Professor JOSEPH LECONTE, dated University of California, May 1, 1875.

I OBSERVE in your work on Corals and Coral Reefs, while discussing the rate of coral growth, you mention an interesting observation of Weinland on the corals about Hayti, bearing on this subject. This recalls to my mind a very similar observation on a much larger scale, made by myself during the winter of 1851, while assisting Professor Agassiz in his examination of the Florida reefs. Knowing your interest in the subject, I send you an account of it.

Professor Agassiz and his party were at Fort Jefferson, Tortugas. Dr. Wm. L. Jones and myself had gone to examine a little island about 8 or 10 miles to the northwest. On returning to Fort Jefferson in a small boat, when about half way between the two islands and in the still shoal water on the inside of the line of reefs, to our great surprise the boat suddenly grounded on the close-set prongs of an extensive grove of madrepores (*Madrepora cervicornis?*). On examining closely the trees of this grove, we found: 1. That the prongs were far more thickly set than is usual in this species; 2. that all the prongs not only of the same tree, but of all the trees of the whole grove, grow up to nearly the same level, which at the time examined was very near the surface; 3. that all the prongs at that level were dead for a distance of one to three inches from the point. The lower limit of death seemed to be a *perfectly horizontal plane.* The dead points rose above it to various distances not exceeding three inches. We rowed around the margin of this grove for a considerable distance and found everywhere the same phenomena. I satisfied myself that the whole grove, for hundreds of acres in extent, had been clipped in a similar manner.

On subsequent inquiry at Key West, I learned that the mean level of the ocean, owing probably to the prevalence of certain winds, was higher during one portion of the year than during the other. It became evident, therefore, that during the high water the living points of the madrepores grow upward until the descending water level exposes and kills them down to a

certain level. With the rise of the mean level again, new points start upward, to be again clipped at the same level by the descending water. The levelness, the thick setting, and the deadness of the points are all thus completely accounted for. It is precisely the phenomena of a clipped hedge.

I have long been accustomed to estimate from these facts the rate of madrepore growth. I have recently looked up the data necessary to do so more accurately.

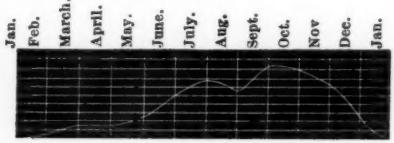
The following table, taken from the Coast Survey Report for 1853, p. 76, gives the mean sea level for the different months of the year.

	Feet.	Dif.		Feet.	Dif.
Jan.	5·10	0	July	·78	·68
Feb.	·15	5	Aug.	·63	·53
March	·26	·16	Sept.	·93	·83
April	·26	·16	Oct.	·90	·80
May	·32	·22	Nov.	·73	·63
June	·60	·50	Dec.	·31	·21

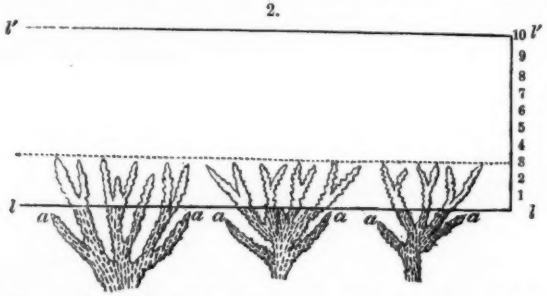
From the differences I have roughly plotted a curve representing the annual variation of mean level.

It is seen that the mean level at Key West is lowest in January and highest in September, the difference being 0 83 feet or about ten inches. Now starting with the lowest mean level in January, *l l*, it is evident that living points *a a a* near that surface would grow upward and continue to grow all the time the water was rising from *l l* to *l' l'*, i. e., from middle of January to the middle of September, and also while it was falling to three inches above *l l*, i. e., until about the beginning of December. At this level

1.



2.



the growing points would be nipped. It is evident, therefore, that the three inches were grown in 10 to 10½ months, which would make about 3½ inches per annum.

This table is taken from Key West; my observations were at the Tortugas. There may be differences in the amount and the curve of variation in different places. But this would make but little difference in the result. I believe we may say with confidence that the annual growth of madrepore points in the Gulf is not more than $3\frac{1}{2}$–4 inches per annum.

ART. X.—*Brief Contributions to Zoology from the Museum of Yale College.* No. XXXIII.—*Results of Dredging Expeditions off the New England Coast in* 1874; by A. E. VERRILL.

IN the last number of this Journal a general statement was made of the operations in connection with the U. S. Fish Commission, located during the summer of 1874 at Noank, Connecticut, on Fisher's Island Sound, and close to the eastern end of Long Island Sound.

In the following article only a brief summary of the results can be given; the full details will eventually appear, however, in the report of the Commissioner.

The total number of recorded stations, where dredgings were made during the summer, is 180, but many others, not registered, were made by members of the party. A large number of additional localities along the shores and in the shallow waters of the harbors were explored by hand nets and otherwise with excellent results. Temperatures were not taken at all the dredging localities, and therefore, in the accompanying table, such localities have been, for the most part, omitted.

The localities dredged may be conveniently grouped as follows:

a. Fisher's Island Sound, mostly hard gravelly and stony bottoms, often rocky, and occasionally with some sand or mud, the depth varying from 4 to 15 fathoms. The tidal currents were rather strong and the bottom temperatures were low (usually 61° to 65° F.).

b. Block Island Sound, including a wide region from off Point Judith, R. I., to Race Point, at the western end of Fisher's Island; the depth varying from 5 fathoms or less to upwards of 40 fathoms, near Race Point (No. 45). The currents are strong, especially toward Race Point, and the temperatures are low (56° to 64°). The bottom is generally gravelly, stony, or sandy, occasionally rocky, and but seldom muddy. An extensive "scollop-bank" (*Pecten tenuicostatus*) occurred in 18 to 22 fathoms, south of Watch Hill, where many interesting species were found, among which was *Leptasterias compta.**

* This species, when living, is of a beautiful violet color (rarely brownish). Occasionally there are six rays. It is a delicate and rather fragile species, the

c Off Block Island and south of Montauk Point, L. I., including various fishing banks or "ledges," among which is Coxe's Ledge, about 18 to 20 miles east-southeast from Block Island. Among these localities there are both hard gravelly and muddy bottoms, and some that are sandy. The greatest depths were 32 to 34 fathoms, muddy, about 10 miles southeast from Block Island (Nos. 161, 162); and 25 fathoms, sandy, about 11 miles southeast from Montauk Point (No. 116). Throughout this region the bottom temperatures were found to be low (45½° to 57°), and the fauna correspondingly arctic.

d. The eastern part of Long Island Sound, from Fisher's Island and Gardiner's Island to the mouth of the Connecticut River, the depths varying from 3 or 4 to 50 fathoms, the deepest water occurring a few miles west of Race Point (see Nos. 35, 36, 45, 46), where the tidal currents are very strong and the bottom rocky. The bottoms are variable, but mostly stony or gravelly, and not unfrequently more or less muddy, while the temperature in all the deeper localities was low (58° to 62°) and the fauna arctic.

e. Shallow water localities in the harbors and estuaries near Noank, Stonington, etc. The bottoms are generally muddy and mostly thickly covered with eel-grass (*Zostera marina*).

f. Gardiner's Bay, Long Island. The localities were mostly sandy; the depths 3 to 10 fathoms; and the bottom temperatures were higher (64° to 68°) and the fauna more southern than in the more open sounds.

g. Great Peconic and Little Peconic Bays, and Greenport Harbor, L. I. In these localities the temperatures were much higher (71° to 72½°) than those of the other localities examined, and the fauna was very decidedly southern, including some species not before observed north of Florida and South Carolina. In Little Peconic Bay the bottoms were mostly sandy and shelly (mainly *Crepidula fornicata*, both dead and living), and the depths were 4 to 13 fathoms. In Great Peconic Bay the water was shallow, 4 to 6 fathoms, and the bottoms muddy and rather barren in all the localities examined.

As the faunæ of the various kinds of bottoms and shores, both of the bays and harbors and of the outer cold waters, have been fully described, and most of the species enumerated by me, in a recent work,* it will not be necessary to give, at this time, more than a summary of those species not included in

rays easily becoming detached. Hundreds of specimens of this hitherto rare species were obtained at this locality. At this place two fishes (a species of *Liparis* and a young hake, *Phycis*) were often found in the gill-cavity of the Pectens with *Pinnotheres maculata*.

* Report on the Marine Invertebrates of Southern New England; Appendix of 1st Report of the U. S. Commissioner of Fish and Fisheries, 1874: also a separate edition.

that report, and now for the first time recorded from the southern coast of New England.

It may, however, be well to state that the fauna of the localities included under the groups *a*, *b*, *c* and *d*, is nearly identical with, though a little more arctic than, that of the outer waters off Martha's Vineyard and Cuttyhunk Island, described in the report referred to; while that of the localities under *e*, *f* and *g*, is essentially the same as that of Vineyard Sound and the estuaries and harbors connected with it, as described in the same work, though the fauna of the Peconic Bays is a little more southern than that of Vineyard Sound or Wood's Hole.

List of species new to the fauna of Southern New England.

In this list I have included, also, a few species added to the fauna during excursions from New Haven, by myself and others, though not obtained during the explorations by the Fish Commission. A few species, marked (*), not new to the fauna, have also been introduced in order to confirm the localities, or to correct the nomenclature. But numerous species, especially of Crustacea and Sponges, added to the fauna last summer, are here omitted, because not yet sufficiently studied. Many of them are undescribed.

Arachnida.

Pycnogonum littorale Müller=*P. pelagicum* Stimpson. West of Race Point, 50 fathoms (Nos. 35, 36).

Thalassarachna Verrillii Packard. Low water and just below, and in pools, among eel-grass, ascidians, hydroids, etc.

Crustacea.

The Crustacea have been identified by Mr. S. I. Smith.

**Hyas coarctatus* Leach. Coxe's Ledge, 21 fathoms; Block I. Sd. (Nos. 85–90).

Dexamine Thea? Boeck. Noank Harbor, among eel-grass.

Melita dentata Boeck. Off Fisher's Island, 9 fathoms; off Watch Hill, 18 fathoms; off Race Pt., 42 fathoms.

Melita, sp. nov. East-southeast 10 miles from Block Island, 32 fathoms, muddy; off Isles of Shoals, N. H., 35 fathoms.

**Ampelisca macrocephala* Lilj.=*Ampelisca*, sp., Smith in Report on Invert., p. 561, pl. IV, fig. 17. Off Buzzard's Bay, 29 fathoms, 1871.

A. typica Boeck. Fisher's I. Sd., 17 fathoms; Block I. Sd., 17 to 19 fathoms (Nos. 74, 75); off Saybrook, Conn.; Noank, among eel-grass.

A. limicola Bate (Stimpson sp.). Noank Harbor, among eel-grass and mud, common; Fisher's I. Sd., 3 to 6 fathoms, sandy.

Ampelisca, sp. nov. Fisher's I. Sd., 7 to 9 fathoms; Block I. Sd., 17 to 19 fathoms (Nos. 74, 75); off Martha's Vineyard, 23 fathoms, 1871.

Xenoclea megachir Smith. Trans. Conn. Acad., 1874. Off Watch Hill, 18 fathoms.

**Hyperia medusarum*. Off New Haven; Noank; Vineyard Sound, and northward, on *Cyanea* and other jelly-fishes.

H. spinipes Boeck. Vineyard Sound.

Several other species of Amphipods, not yet determined, were obtained.

Anilocra, sp. New Haven, in mouth of *Loligo* (Clark).

Tanais vittatus Lilj. Noank Harbor, on piles at low water, and among eel-grass.

Other species of Isopods occurred, among them a curious new species allied to *Paranthura*, from off Watch Hill, 18 fathoms.

Argulus, sp. On *Fundulus pisculentus*, Noank, etc.

Several undetermined species of Lernæans occurred on the sturgeon, drum-fish (one in the gill-cavity and another on the skin and fins), orange file-fish, skate, etc.

Balanus porcatus Costa. Off Watch Hill, 18 fathoms; Long. I. Sd., 24 to 50 fathoms, off Race Point, (Nos. 35, 36, 47).

Annelida.

Sthenelais, sp. nov. Various localities in Block I. Sd.; Fisher's I. Sd.; and Long. I. Sound, 10 to 40 fathoms, on sandy bottoms.

Pholoe minuta Malmgren. Block I. Sound, 17–21 fathoms, mud.

Nephthys cæca Malmgren. Off Stonington, 4–5 fathoms, Aug. 16.

Phyllodoce Grœnlandica Œrsted. Fisher's Island Sound, 12–14 fathoms.

Procerea gracilis Verrill. Noank Harbor.

Eusyllis lucifera Verrill, sp. nov.* Noank, on piles, and eel-grass, July 11–31.

Syllis pallida Verrill, sp. nov.† Plate III, fig. 6. Noank Harbor, Aug. 15–17.

Syllis, sp. A yellowish white species, with broad obtuse palpi, and moniliform antennæ and cirri; Block Island Sound, 17–21 fathoms, Aug. 21.

Lumbriconereis obtusa Verrill. Noank Harbor, 1–1½ fathoms, mud and dead eel-grass, July 8.

L. acuta Verrill, sp. nov.‡ Off Block Island, 14 fathoms, Aug. 19.

Ophelia denticulata Verrill, sp. nov.§ Off Block Island, 14 fathoms, Aug. 19.

Arenicola marina Malmgren. In sand at low-water on a beach about 3 miles west of Noank, July 9.

Trophonia aspera Stimpson.

Brada, sp. Block I. Sound, 17–24 fathoms.

Polydora, sp. Burrowing in dead shells of *Pecten tenuicostatus;* off Block Island; Block I. Sound, 18–21 fathoms.

Polydora, sp. Noank Harbor, 1–1½ fathoms, mud and dead eel-grass.

Praxilla, sp. Off Sea-flower Reef, 6–9 fathoms, sand.

Ancistria capillaris Verrill. Off Block Island, 15–20 fathoms, mud.

Cistenides granulata Malmgren. Long I. Sound, off Race Point, 50 fathoms.

Thelepus cincinnatus Malmgren. Coxe's Ledge, 20 fathoms, sand and gravel.

Polycirrus, sp. A bright red species, with brilliant blue phosphorescence. Off Watch Hill, 18–22 fathoms; Coxe's Ledge, 20 fathoms; Bay of Fundy, low-water to 50 fathoms.

* *Eusyllis lucifera* Verrill, sp. nov.

Body rather slender, about 18mm. long; head broader than long, emarginate behind, wider and broadly rounded in front, eyes rather large, the anterior pair a little wider apart than the posterior; palpi broad and short, about one-third as long as the head, blunt or obtusely rounded in front; antennæ stout, tapering, the median considerably longer and larger than the lateral, about equal to twice the breadth of the head; tentacular cirri, like the antennæ and dorsal cirri, transversely wrinkled, the upper ones about equal to the median antennæ, the lower ones a little smaller; dorsal cirri of the first segment longer than the antennæ, the length exceeding three times the breadth of the head; cirri of the two following segments less than half as long; those on the fourth longer and on succeeding segments generally alternately longer and shorter, but mostly less than half the diameter of the body. Color yellowish white, with a dark intestinal line. Phosphorescent with a bright green light.

† *Syllis pallida* Verrill, sp. nov. Plate III, figure 6.

Body slender, tapering to both ends, about 15mm. long and ·5 to ·75mm. broad. Head small, length about equal to breadth, rounded behind, produced in front, with a slight antero-lateral angle on each side; palpi large, elongated, lanceolate, obtuse at tips; eyes small, the anterior very wide apart. Antennæ and cirri rather short, distinctly annulated or moniliform; the median antenna largest; dorsal cirri variable in length, or alternately longer and shorter. The longer ones about one half longer than the breadth of the body, composed of 17 or 18 annulations. Color white, with a yellowish intestinal line posteriorly. None of the setæ have setiform tips.

‡ *Lumbriconereis acuta* Verrill, sp. nov. Plate III, fig. 5.

This is a slender species, easily distinguished by its very long acute head, which is about three times as long as broad. The lateral appendages are short, with a short obtuse upper lobe.

§ *Ophelia denticulata* Verrill, sp. nov.

Body long and round; 9 anterior segments with short setæ; 18 with slender tapering branchiæ, denticulate on the front edge; 5 caudal segments with long setæ; anal segment with 16 to 18 slender acute papillæ, and two larger lanceolate ones below. Length, 70mm.; diameter, 6mm.

Pista cristata Malmgren. Long Island Sound, off New London, 8 fathoms, mud and sand (loc. 17), July 17.

Chone, sp. North of Block I., 18–24 fathoms, mud and sand, Aug. 6; Coxe's Ledge, 21 fathoms.

Filigrana implexa Berkeley. Fisher's I. Sound; Coxe's Ledge, 21 fathoms.

Spirorbis nautiloides (?) Lamarck. Fisher's I. Sound; Coxe's Ledge, 21 fathoms.

Spirorbis, sp. Shell bicarinated. With last.

Bdellodea, Gephyrea, etc.

Ichthyobdella, sp. Parasitic on sculpin (*Cottus*, sp.), Thimble Islands, May, 1874. Whitish, with reddish intestinal lines.

Chætoderma nitidulum Loven. Off Block I., 32–34 fathoms, mud (loc. 161, 162.)

Tristoma læve Verrill,* sp. nov. Block I., in mouth of bill-fish.

T. cornutum Verrill.† Block I., on gills of bill-fish (*Tetrapturus albidus*).

Nitzschia elegans Baer. On gills of sturgeon (*Acipenser oxyrhynchus* Mitchel).

Turbellaria.

Lineus viridis V. = *Nèmertes viridis* Verrill, Rep. on Invert., p. 628. Noank, low water and 1 fathom, mud.

Tetrastemma dorsalis McIntosh. Noank harbor, on eel-grass and in 1–1½ fathoms, mud, July 8; Casco Bay.

T. elegans Verrill (= *Hecate elegans* Girard). Fisher's Island Sound.

Body about 14mm. long, slender, depressed, tapering to tail; head wider than neck, obtuse or emarginate; eyes conspicuous, nearly in a square, the anterior ones a little nearer together than the posterior. Color of body light yellow, with a broad band of deep brown on each side, leaving a wide dorsal stripe. A pale yellow variety (?), from Noank harbor, has the lateral bands rather ill-defined, consisting of more or less separated specks.

T. candida (?) Œrsted. Noank harbor, 1–1½ fathoms, mud; Casco Bay.

Amphiporus bioculatus McIntosh. Noank harbor, 1–1½ fathoms, mud, July 7; Fisher's I. Sd., 7 fathoms, mud and sand.

A. hastatus McIntosh (?). Block I. Sd., 18–45 fathoms, Aug. 6.

Cephalothrix linearis Œrsted. Noank harbor, 1–1½ fathoms, mud and eel-grass; Casco Bay, low water.

Gastropoda and *Lamellibranchiata.*

**Scalaria Grœnlandica*. Block Island Sound, 17–24 fathoms, Aug. 6.

Velutina lævigata. Off Watch Hill, 18–20 fathoms.

* ***Stylifer Stimpsonii*** Verrill. Block I. Sound (Nos. 85–90), 6–15 fathoms.

* ***Tonicella marmorea*** Carpenter. (*Chiton marmoreus* Gould.) Off Block Island.

Philine quadrata. Off Montauk Point, 20–25 fathoms, sand (Nos. 115, 116).

Montagua Bostoniensis (Cauthouy, sp.). South of Fisher's Island, 32 fathoms, Aug. 11 (No. 91); off Montauk Point, Aug. 13 (No. 14).

Embletonia fuscata Gould; also var. *remigata* and var. *lanceolata* (Gould). Occurs of all shades of color, from pale flesh-color to dusky brown. Piles at Noank, common on hydroids.

* ***Tristoma læve*** Verrill, sp. nov.

Length about 15mm., very thin, and broad elliptical; anterior end somewhat produced and broadly rounded; posterior end emarginate; dorsal surface smooth; lower with minute granule-like papillae. Color white, translucent. Posterior sucker large, about a third of the breadth of the body, campanulate, the central area large, with seven angles, from which seven lines radiate; the edge is divided into very numerous denticles; anterior suckers also large, about one-half as broad as the posterior, separated by a space less than their diameter.

† ***Tristoma cornutum*** Verrill, sp. nov.

Body thin, broad elliptical, or oblong, emarginate posteriorly; anterior end narrowed, produced, and with a short, tapering, tentacle-like process at each angle; upper surface with minute rounded granules and small scale-like wrinkles; smooth beneath. Posterior sucker small, less than one-fourth the breadth of the body, its border divided into much fewer and larger teeth than in the preceding species; anterior suckers two-thirds as broad as the posterior, nearly two diameters apart. Color light red or flesh-color.

Doto formosa Verrill, sp. nov.* Off Point Judith, 10–14 fathoms, Aug. 19.

Idalia modesta Verrill, sp. nov.† Off west end of Fisher's Island, Aug. 25, 1874, on sandy and muddy bottom; Block Island Sound, 17–24 fathoms, Aug. 6; north of Little Gull Island, 40 fathoms (No. 19).

Entalis striolata Stimpson. Off Block Island, 20–25 fathoms (115, 116).

Thracia myopsis. West of Fisher's Island, 7–9 fathoms, Aug. 25.

Tunicata.

Amaræcium glabrum Verrill. Off Block Island.

Bryozoa.

* *Discoporella verrucaria* Smitt=*Diastopora patina* Verrill, in Report on Invert. S. N. E., 1873. Fisher's Island Sound.

**Tubulipora serpens* (irregular variety)=*T. flabellaris* Verrill, in Report on Inv.

Alcyonidium, sp. A smooth red species, incrusting shells. Off Watch Hill, 18–22 fathoms, on shells of *Pecten;* Casco Bay; Bay of Fundy.

Bicellaria ciliata Blainville. Fisher's I. Sound, 8–12 fathoms; Bay of Fundy, 10 to 30 fathoms; off Gay Head, 19 fathoms.

* *Biflustra tenuis* V.=*Membranipora tenuis* Desor; Verrill, in Report on Invert., p. 712. Low-water to 40 fathoms.

Membranipora unicornis Flem., and *var. Americana* (D'Orb.). New Haven, on algæ, etc.; Fisher's I. Sound; Block I. Sound; Casco Bay; Bay of Fundy, etc.

**Cribrilina puncturata* Smitt. Plate III, fig. 2,=*Escharipora punctata* V., in Rep. on Invert., p. 713. New Haven, Noank, etc.

Porina ciliata Smitt. New Haven, on red algæ; Thimble Islands; Fisher's I. Sound; Vineyard Sound, 5–8 fathoms, on shells of *Mactra.*

Escharella pertusa ?.‡ Fisher's I. Sound; Block I. Sound; eastern end of Long I. Sound, 8–40 fathoms; Bay of Fundy.

Hippothoa biaperta Smitt.§ New Haven, on red algæ; Thimble Islands, in pools; off Watch Hill, 3–5 fathoms; Vineyard Sound, abundant.

H. reversa V., sp. nov.‖ Off Gay Head.

Eschara verrucosa, var. propinqua Smitt. Off Buzzard's Bay, 25 fathoms; Nantucket Shoals, abundant; Bay of Fundy, etc.

* *Doto formosa* Verrill, sp. nov. Plate III, fig. 4.

Dorsal papillæ about 8 on each side, stout, ovate, narrowed at base, covered with numerous short, obtuse or rounded, small, white-tipped papillæ. Tentacles slender, the sheaths funnel-shaped, obliquely truncated, with slight emarginations in front and on the outer side. Body translucent white; tentacle-sheaths and dorsal papillæ covered with flake-white specks. Length about ·5 of an inch.

† *Idalia modesta* Verrill, sp. nov. Plate III, fig. 3.

Body oval, very convex. Tentacles long, about equal to breadth of body, slightly serrate or wrinkled; obtuse; cirri at their bases about half as long, very slender, with acute white tips. Branchiæ about 12, rather long, pinnate; two slender cirri close together, behind the bases of the gills on each side; four much smaller conical papillæ in a row on each side. Color of back and branchiæ deep orange-brown, mottled with yellowish and greenish white. Length about ·5 of an inch.

‡ This species has large zoœcia, with numerous coarse pores; oœcia large, subglobular, roughened with prominent granules, and perforated by small pores; apertures with a broad shallow sinus, and small lateral denticles within; avicularia lateral, rarely present, opposite the side of the aperture, broad, obtusely rounded, the point directed toward the aperture.

§ To the genus *Hippothoa*, as limited by Smitt in his recent work on Florida Bryozoa, belong *Escharella variabilis* and *Mollia hyalina* of my Report on Invert. of Southern New England. The former is very nearly allied to, if not identical with *H. Isabelleana* of Smitt, Florida Bryozoa, p. 44, plate VIII, figs. 166–168, 1873.

‖ *Hippothoa reversa* Verrill, sp., nov. Plate III, fig. 1. Zoœcia oblong, the front perforated with scattered pores of moderate size; apertures rounded, with a shallow rounded sinus; a small mucro is often present in front of the aperture; avicularia narrow, elongated, acute, somewhat curved, raised above the level of the zoœcia, the point most raised, and directed outward and backward.

Cellepora avicularis Hincks. Off New Haven; Fisher's I. Sound; St. George' Bank; Bay of Fundy, etc. Common on *Sertularia*.

**Lepralia Americana* Verrill. This Journal, vol. ix, p. 415, plate VII, figs. 4, 5, =*L. Pallasiana?* Verrill, Report on Invert., p. 713, 1873. New Haven Harbor; Noank, on eel-grass, etc.; Vineyard Sound; Beverly, Mass.; Long I. Sound, low-water to 40 fathoms (loc. 29), on shells, stones, etc., with oœcia.

Discopora nitida Verrill. This Journal, ix, p. 415, pl. VII, fig. 3, June, 1875. Thimble Islands, on algæ in pool at low-water; Fisher's I. Sound, 3 to 12 fathoms; Vineyard Sound, 5 to 10 fathoms, common on shells.

Echinodermata.

Lophothuria Fabricii Verrill. Off Block Island, 20–21 fathoms (157–9).

Acalephæ.

Bolina alata Agassiz. Newport, R. I. (A. Agassiz).

Campanularia verticillata Lamarck. Block I. Sd., 17–45 fathoms; Fisher's I. Sd., 4–11 fathoms.

C. calceolifera Hincks. Plate IV, fig. 6. Noank, on bottom of scow; Wood's Hole, on piles, 1871.

Clytia noliformis (McCready). Plate IV, fig. 2. New Haven, Sept., 1874.

Gonothyræa hyalina Hincks. Off Watch Hill, R. I., 18 fathoms, July 31.

G. Loveni Allman. Noank, on piles of wharf.

G. gracilis Allman. Fisher's I. Sd., 4–13 fathoms; off Watch Hill, 18 fathoms; off Montauk Pt., 6–20 fathoms.

G. tenuis Clark, sp. nov.* New Haven, on piles of Long Wharf, June, 1875 (Clark).

Obelia bidentata Clark. sp. nov.† Greenport, L. I., on piles, Aug. 5.

O. bicuspidata Clark, sp. nov.‡ Off Thimble Islands, 4–5 fathoms, rocks, Sept., 1874.

Opercularella lacerata Hincks. New Haven, on piles, May, 1875 (Clark).

O. pumila Clark, sp. nov.§ Portland, Me., on piles; off Montauk Pt., 5–15 fathoms.

Halecium articulosum Clark, sp. nov.‖ Long I. Sound, 8–12 fathoms; Coxe's Ledge, 17–21 fathoms; Casco Bay; Bay of Fundy.

* *Gonothyræa tenuis* Clark, sp. nov. Closely allied to *G. Loveni*, but has narrow, elongated, obconic gonothecæ, tapering gradually to the base.

† *Obelia bidentata* Clark, sp. nov. Plate IV, fig. 10.

Stems clustered, compound, nearly straight, thickly branched; mode of branching irregular, a few of the lower branches sometimes attaining a considerable length and resembling the main stem; branchlets and ends of the branches simple, slender, translucent and very graceful. Hydrothecæ very deeply campanulate with 9–12 longitudial lines, and the rim ornamented with very acutely bidentate teeth.

‡ *Obelia bicuspidata* Clark. sp. nov. Plate IV, fig. 11.

Stem erect, slender, compound, sparingly branched; branches short, slender, ascending and irregularly arranged. Hydrothecæ very deeply campanulate, narrow, very hyaline, and with 8–10 longitudinal lines extending from the distal extremity nearly to the base. The rim is armed with acutely bidentate teeth.

§ *Opercularella pumila* Clark, sp. nov. Plate IV, figs. 7, 8, 9.

Stem rather stout, erect or creeping, slightly flexuous, sparingly branched. Hydrothecæ largest in the middle, tapering very slightly toward the base and rapidly converging toward the distal end; operculum composed of a few convergent segments, not very deep. Gonothecæ fusiform, about twice the length of the hydrothecæ.

‖ *Halecium articulosum* Clark, sp. nov.

Stem stout, compound, sparingly branched, dark brown or black; branches short and irregularly arranged on all sides of the stem; branchlets few and very short; branches and branchlets divided into short, stout internodes by distinct joints placed at right angles to the stem. Hydrothecæ short and wide. Gonothecæ sessile, borne in rows on the upper side of the pinnæ. The female are obovate, and have the opening on one side, nearer the distal end. The male gonothecæ are oblong, subcylindrical.

Halecium halecinum Johnst. Off Saybrook, 14–23 fathoms; Block I. Sound, 17–45 fathoms; Fisher's I. Sound, 4–11 fathoms.

H. Beanii Johnston. Off Saybrook, 6–23 fathoms; Fisher's I. Sd., 7–11 fathoms; Block I. Sd., 17–21 fathoms. Casco Bay; Bay of Fundy.

Lafoea cornuta Lamx., 1812=*L. dumosa* Sars (Flem. sp.). Nantucket Shoals.

Cuspidella costata (?) Hincks. Fisher's I. Sd., 9–11 fathoms.

Calycella syringa Hincks. Plate IV, figs. 3, 4, 5. Fisher's I. Sd., 4–14 fathoms, many localities; Block I. Sd., 17–45 fathoms; off Saybrook, 6–8 fathoms.

Do. var. pygmæa (Hincks). Fisher's I. Sd., 5½–6½ fathoms.

Sertularella polyzonias Gray, *var. gigantea* Hincks = *Cotulina tamarisca* A. Ag., Catal. Acal. N. A. Off New London, 6 fathoms; Gardiner's Bay, 6–8 fathoms; Block I. Sound, 17–24 fathoms.

S. rugosa Gray. Noank, on piles of wharf; off Watch Hill, 17–21 fathoms.

Diphasia fallax Agassiz. Off Watch Hill, 17–21 fathoms.

D. rosacea Agassiz. Fisher's I. Sound, 9–11 fathoms, July 14, with gonothecæ.

Sertularia gracilis Hincks. Hyannis, Mass., on *Sargassum*.

Rhegmatodes Floridianus Agassiz. Greenport Harbor, L. I., Aug. 5; Florida.

Staurophora laciniata Agassiz. Fisher's I. Sound, July.

Corynitis Agassizii McCr. Greenport Harbor, Aug. 5; Charleston, S. C.

Thamnocnida spectabilis Agassiz. Noank Harbor, on bottom of vessel.

Tubularia indivisa Linn. Off Saybrook, 4–9–22 fathoms; Fisher's I. Sound, 4–11 fathoms; Block I. Sound, 17–24 fathoms; off Block Island, 14 fathoms.

Anthozoa.

Cerianthus borealis Verrill, (young specimen). Off Watch Hill, R. I., 18 fathoms, July 31.

Urticina crassicornis Ehrenberg. Fisher's I. Sound, 12–14 fathoms; Block I. Sound, 6–8 fathoms (Nos. 85–90); off Watch Hill, 18 fathoms.

Several sponges, new to the fauna, were also obtained and were studied by Prof. Hyatt. Among them is a curious very slender and delicate, bipinnately branched species from the piles, both at Greenport and Noank. Numerous ciliated Protozoa were also observed, but are mostly not accurately identified. Among them is the curious *Freia ampulla*, on eel-grass, and also on *Sertularia* from 50 fathoms. Some of the Rhizopods were studied by Dr. E. Bessels, and others by Dr. Joseph Leidy.

Explanation of Plates.

Plate III.—Figure 1. *Hippothoa reversa* V., enlarged 32 diameters.
" Figure 2. *Cribrilina puncturata* Smitt. Off Noank.
" Figure 3. *Idalia modesta* V., enlarged about 6 diameters.
" Figure 4. *Doto formosa* V., enlarged about 10 diameters.
" Figure 5. *Lumbriconereis acuta* V., much enlarged.
" Figure 6. *Syllis pallida* V., much enlarged.

Figures 1, 2, 3, were drawn by the author; 4, by J. H. Emerton; 5 and 6, by J. H. Blake.

Plate IV.—Figure 1. *Clytia Johnstoni*, enlarged 16 diameters.
" Figure 2. *C. noliformis* V., 16 diameters.
" Figure 3. *Calycella syringa*, 32 diameters.
" Figures 4, 5. The same, showing peculiar variations.
" Figure 6. *Campanularia calceolifera*, 16 diameters.
" Figure 7. *Opercularella pumila* Clark, from Portland, Me.
" Figure 8. The same, creeping form.
" Figure 9. The same, young stems from off Montauk Point.
" Figure 10. *Obelia bidentata* Clark, 16 diameters.
" Figure 11. *O. bicuspidata* Clark, 16 diameters.

Figure 2 was drawn by the author; the rest by Mr. S. F. Clark; all with camera-lucida.

[To be continued.]

Art. XI.—*Examination of Gases from the Meteorite of Feb.* 12, 1875; by Arthur W. Wright.

This meteorite fell, on the date above mentioned, in Iowa County, in the State of Iowa. By the agency of Professor N. R. Leonard, of the Iowa State University, a large amount of the meteoric mass was collected, and from him, by the courtesy of President Thacher of the same institution, a number of fragments were received by the writer, for an examination, of which a brief notice was published in the preceding number of this Journal. A description of the meteorite, and of the circumstances which attended its fall, by Prof. Leonard, will be given in the next number of the Journal.

The meteorite is of the stony kind, not greatly differing in its general appearance from others of the same class. Numerous small grains of metallic iron and of the magnetic sulphide of iron, or troilite, are scattered through the mass, the iron grains ranging in size from the finest particles, like mere powder, to those of the size of a fig-seed, with occasionally one as large as a grape-seed.

Among the fragments received, there are some which show distinct evidences of a sort of lamination or imperfect stratification, the portions at which the surfaces separated being smoothed down, as if by pressure or friction. Several minute veins are visible, which appear to be filled with material of somewhat different constitution. Their relation to the general mass cannot be distinctly made out, and it is doubtful whether they indicate anything more than that cracks formed in the mass while cooling, and that the fissures thus formed were filled up again, perhaps by the still fluid matter from the interior. They seem to indicate that the mass of which the meteorite probably once formed a part was of great size.

The recent investigations of Prof. Newton, Schiaparelli, Oppolzer, and others, in respect to some of the great meteoric streams, have resulted, on the one hand, in establishing the identity of their orbits with those of certain well-known comets, and on the other, in showing that the bodies belonging to these streams are probably of the same nature as the sporadic or occasional meteorites. It seemed probable, therefore, that an examination of the gases yielded by a freshly fallen meteorite would be likely to furnish important information respecting the tails of comets, and these anticipations were found to be not unwarranted by the results.

The examination was made in the manner described in a previous article,* and with the same apparatus. The first trial,

* This Journal, III, ix, Apr., 1875, p. 294.

which was made with a quantity of the iron extracted from the meteoric mass, showed that the gaseous contents differed in a marked degree from those obtained from iron meteorites hitherto examined, inasmuch as they contained a very large percentage of carbon di-oxide, with a smaller proportion of carbonic oxide, and a large residue of hydrogen, the two oxides of carbon making about one half of the gaseous mixture. The percentages obtained in the preliminary trial were, CO_2, 35; CO, 14; or 49 per cent of carbon compounds, the hydrogen not having been estimated. This was merely a rude approximation, and the amount of CO is overstated, at the expense of the CO_2. These results were obtained with the particles of iron separated from the powdered stone with a magnet. The residue, however, contained a considerable amount of iron in particles too small to enable them to lift the bits of the stony matrix in which they were enclosed. As this was found to introduce irregularities in the determinations, the portions of meteorite employed in the experiments to be described were finely pulverized in a diamond mortar, and the whole immediately placed in the glass tube to be attached to the Sprengel pump, the iron not being separated from the rest. Larger volumes of the gases were extracted than in the first trial, and the relative proportions of the different constituents carefully determined by analysis.

Powder formed from about four cubic centimeters of the solid meteorite was placed in the tube upon the pump, and the air very thoroughly exhausted. It was soon found that the relative amounts of the different constituents driven off by heating the tube varied with the temperature, and the experiments were so conducted that the portions separated at different temperatures could be examined separately.

On applying the heat of the hand to the tube for a short time, a small amount of gas was liberated, too small for anything more than a rude qualitative test as to its composition, which showed the presence of carbon di-oxide and some hydrogen. The tube and its contents were then brought to the temperature of boiling water by surrounding it with a wider glass tube, through which steam was passed for several hours. Gas was given off in considerable quantity, and enough was collected for an analysis. This was found to contain 95·46 per cent of carbon di-oxide, and 4·54 per cent of hydrogen, the carbonic oxide, if present, being in too small amount for estimation with certainty. A moderate heat was now applied for a short time with a small Bunsen flame, raising the temperature to 200° or 250°. This separated a still greater quantity of the gases, in the following proportions: CO_2, 92·32; CO, 1·82; H, 5·86. A stronger heat was then applied for nearly an hour, the tempera-

ture, however, being kept below that of redness. About three cubic centimeters of gas were given off, which was found to consist of CO_2, 42·27; CO, 5·11; H, 48·06; N. 4·56. The tube with its contents was now brought to a low red heat, which was maintained for half an hour or so, the effect being to liberate nearly the same volume of gas as before, containing CO_2, 35·82; CO, 0·49: H, 58·51; N, 5·18. Finally it was brought to a full red heat, which caused the evolution of much more gas, yielding, on analysis, CO_2, 5·56: CO, 0·00: H, 87·53; N, 6·91. The whole amount of gas given off was about two and one half times the volume of the solid portion of the meteorite employed, but this was not the whole, for the heat was discontinued before its evolution had entirely ceased. If referred to the iron alone, it would be about twenty times its volume.

The following table gives a comparative view of the relative proportions of the gases obtained at different temperatures, the nitrogen being determined as a residue:

	At 100°.	At 250°.	Below red heat.	At low red heat.	At full red heat.
CO_2	95·46	92·32	42·27	35·82	5·56
CO	0·00?	1·82	5·11	0·49	0·00
H	4·54	5·86	48·06	58·51	87·53
N	0·00	0·00	4·56	5·18	6·91
	100·00	100·00	100·00	100·00	100·00

No hydrocarbon compounds of the olefiant series, capable of absorption by fuming sulphuric acid were found, nor any marsh gas. A very small percentage of the latter would have been readily detected. Tests were applied for sulphurous oxide, hydrogen sulphide, and chlorine, but there was no indication of the presence of these gases A small amount of water vapor was driven off by the heat, but not apparently more than the ordinary quantum of hygroscopic moisture which such a substance would absorb from the air.

It will readily be seen, on reviewing the above results, that they show a marked distinction between the iron and the stony meteorites, as to the gases which they contain. For, while hydrogen is the principal gas of the irons, in the Lenarto specimen amounting to 85·68 per cent,* in those of the stony kind, if the one examined may represent the class, the characteristic gas is carbon di-oxide, and this, with a small proportion of carbonic oxide, makes up more than nine-tenths of the gas given off at the temperature of boiling water, and about half of that evolved at a low red heat. It is probable that a portion of the carbon di-oxide is merely condensed upon the finer particles of the iron, while the hydrogen and carbonic oxide are absorbed

* Graham, Proc. Royal Soc., xv, 502.

within it, as it is a familiar characteristic of iron, platinum and some other metals, that in the state of minute subdivision they take up large portions of gas by condensation. The gas thus fixed would be more easily liberated by heat than that really absorbed. This would explain the fact that the amount of carbon di-oxide given off was much greater at a low than at a high temperature, and that the percentage of the hydrogen increased, as was observed in all the trials, with an increase in the temperature to which the material was subjected.

The spectrum of the gases was observed by means of a vacuum-tube, of the kind ordinarily used for spectroscopic work, attached to the apparatus. As was to be expected, it consisted of the hydrogen and carbon spectra together, bearing a general resemblance to those of gases from iron meteorites, but differing from them in the greater relative intensity of the parts due to carbon compounds. At a few millimeters pressure, indeed, the hydrogen spectrum was almost overpowered by them, and was relatively weak. The three middle carbon bands, those in the yellow and green, were very bright, that in the green being most intense of all. In the broad part of the tube these constituted nearly the whole of the spectrum visible, the green hydrogen line being discernible with difficulty, and the others not at all.

These are precisely the three bands observed in the spectrum of some of the comets, and they have the same relative order of intensity. This is a very significant fact, for it shows that it is quite unnecessary to assume the existence of volatile hydrocarbons for the explanation of cometary spectra, as is done by some writers, and that the presence of the two oxides of carbon in such quantity is quite sufficient to account for all that has been observed, taking into consideration the circumstance that the tension of the gases in the cometary appendage must be extremely small, and the energy of the electric discharge very feeble.

There is a high degree of probability that, if a large comet should hereafter approach near enough to the sun to have its nucleus intensely heated, the hydrogen lines will be found in its spectrum, in addition to the bands heretofore observed. One cannot help regretting that a comet like Donati's should have departed into space just early enough to escape observation with the spectroscope.

The spectrum of bright lines or bands indicates that the gas gives out some light directly, in addition to that which it reflects The most obvious, and also the most probable cause, for this luminosity is electricity. Certainly a disturbance of the electrical equilibrium would result from the heating effect of the

solar rays, and a change of electrical potential, with consequent discharges, would be produced by the motion of the gaseous molecules from the nucleus and from each other, as also by the change in the distance from the sun, provided either of the bodies possessed an electrical charge, as can hardly fail to be the case.

There is another supposable cause for the light which suggests itself, however, in the property of gaseous bodies, that they emit light of the same character as that which they absorb. It is not altogether improbable that the solar radiations absorbed by the gaseous matter, though for the most part converted into heat, would also in part be emitted again as light, and that in the case of volumes of gas filling many cubic miles, the intensity might be sufficient to give a distinct spectrum of bright bands or lines, even though, on the scale of any possible experiment, no trace of such an action can be detected.

These results have thus an important bearing upon the theory of comets and their trains, and if this meteorite may be taken as a representative of its class, they warrant the following conclusions :

1. The stony meteorites are distinguished from the iron ones by having the oxides of carbon, chiefly the di-oxide, as their characteristic gases, instead of hydrogen.

2. The proportion of carbon di-oxide given off is much greater at low than at high temperatures, and is sufficient to mask the hydrogen in the spectrum.

3. The amount of the gases contained in a large meteorite, or a cluster of such bodies, serving as a cometary nucleus, is sufficient to form the train as ordinarily observed.

4. The spectrum of the gases is closely identical with that of several of the comets.

We may consider a comet, then, as merely a meteorite of considerable magnitude, or a swarm of many of lesser size, containing large quantities of carbon di-oxide, with some carbonic oxide and hydrogen, and giving off these gases under the influence of solar heat. The gaseous substance in streaming away forms the train, which is visible, partly by reflected sunlight, and partly by its own light due to some molecular or electrical action, which causes it to give the spectrum of the carbon compounds. The form of the train points to a repulsive influence of some kind, as has been shown by Prof. Norton,* but whether this is due to a specific action of the sun's rays, as is held by Faye, or is electrical in its nature, as maintained by Zöllner, must still be regarded as a subject for investigation.

* This Journal, II, xxix, 79, 383.

The loss of the gaseous contents by the action of solar heat readily explains the loss of the tail and diminution of brightness observed in the case of several comets in their successive revolutions, and their final disappearance from sight will follow as an inevitable consequence, the number of revolutions necessary to deprive them of their gaseous contents depending principally upon their size and the nearness of their approach to the sun at their perihelia.

The combustion of the hydrogen and carbonic oxide contained in meteorites, when liberated by the heat caused by their entrance into the atmosphere, must contribute greatly to increase the intensity of the heat, and both in this way, and by the consequent sudden expansion of the imprisoned gases, may have much to do with the bursting of the masses, and the violent detonations which attend their appearance.

Yale College, June 16, 1875.

ART. XII.—*Discovery of two new Asteroids;* by Professor C. H. F. PETERS. (Letter to one of the Editors, dated Ashfield Observatory of Hamilton College, Clinton, N. Y., June 6, 1875.)

Two new asteroids were found by me on the night of June 3, and observed as follows:

Asteroid (144) *Vibilia.*

1875, June 3,	$15^h\ 3^m\ 2^s$ m. t.	$\alpha = 17^h\ 21^m\ 8^s{\cdot}34$
" 4,	$11\ 17\ 58$ "	$17\ 20\ 18{\cdot}75$

$$\delta = -23^\circ\ 20'\ 57''{\cdot}2$$
$$-23\ 21\ 37\ {\cdot}3$$

Asteroid (145) *Adeona.*

1875, June 3,	$14^h\ 41^m\ 7^s$ m. t.	$\alpha = 17^h\ 16^m\ 6^s{\cdot}85$
" 4,	$11\ 44\ 7$ "	$17\ 15\ 14\ {\cdot}10$

$$\delta = -23^\circ\ 4'\ 18''{\cdot}9$$
$$-23\ 6\ 41\ {\cdot}0$$

The magnitude of (144) is estimated as the 10th, that of (145) as the 11·5th.

ART. XIII.—*The Discovery of a method of obtaining Thermographs of the Isothermal Lines of the Solar Disc;* by ALFRED M. MAYER.

ON June the 5th, 1875, I devised a method for obtaining the isothermals on the solar disc. As this process may create an entirely new branch of solar physics, I deem it proper that I should give a short account of it in order to establish my claim as its discoverer.

In the American Journal, July, 1872, I first showed how one can, with great precision, trace the progess and determine the boundary of a wave of conducted heat in crystals, by coating sections of these bodies with Meusel's double iodide of copper and mercury, and observing the blackening of the iodide where the wave of conducted heat reaches 70° C. If we cause the image of the sun to fall upon the smoked surface of thin paper, while the other side of the paper is coated with a film of the iodide, we may work on the solar disc as we formerly did on the crystal sections.

The method of proceeding is as follows: Beginning with an aperture of object-glass which does not give sufficient heat in any part of the solar image to blacken the iodide, I gradually increase the aperture until I have obtained that area of blackened iodide which is the smallest that can be produced with a well defined contour. This surface of blackened iodide I call the *area of* maximum temperature. On exposing more aperture of object-glass, the surface of blackened iodide extends and a new area is formed bounded by a well defined isothermal line. On again increasing the aperture another increase of blackened surface is produced with another isothermal contour; and on continuing this process I have obtained maps of the isothermals of the solar image. By exposing for about 20 minutes the surface of iodide to the action of the heat inclosed in an isothermal, I have obtained thermographs of the above areas; which are sufficiently permanent to allow one to trace accurately their isothermal contours. There are other substances, however, which are more suitable than the iodide for the production of permanent thermographs.

The contours of the successively blackened areas on the iodide are *isothermals*, whose successive thermometric values are inversely as the successively increasing areas of aperture of object glass which respectively produced them.

As far as the few observations have any weight, the following appear to be the discoveries already made of this new method. (1) There exists on the solar image an area of sensibly uniform temperature and of maximum intensity. (2) This area of maxi-

mum temperature is of variable size. (3) This area of maximum temperature has a motion on the solar image. (4) The area of maximum temperature is surrounded by well-defined isothermals marking successive gradations of temperature. (5) The general motions of translation and of rotation of these isothermals appear to follow the motions of the area of maximum temperature which they inclose; but both central area and isothermals have independent motions of their own.

On projecting the enlarged image of a sun-spot on the blackened surface and then bringing a hot water box, coated with lamp-black, near the other side of the paper, one may *develop* the image of the spot in *red* on a dark ground. A similar method probably may serve to develop the athermic lines in the ultra-red region of the solar and other spectra.

South Orange, N. J., June 11th, 1875.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the Action of a Weaker Acid on the Salts of a Stronger one.*—The importance in chemical dynamics of the question, what is the condition in which several substances exist when in solution, has been oftener recognized than experimentally investigated. Bergmann advanced long ago the theory which is now generally maintained; i. e., that universally bodies combined according to the strength of their chemism. Berthollet, on the other hand, asserted that when different salts were dissolved together, as many bodies were formed as, by the exchange of acids and bases, were possible. Among the experiments made to settle this question, those of Bettendorff* are perhaps the most satisfactory. By studying the action of light on certain solutions, he was led to decide for the view of Bergmann. Hübner and Wiesinger, not regarding these experiments of Bettendorff's as sufficiently numerous or comprehensive, have made use of a different method of solving the problem, by making the distinct proposition: Can a dissolved acid expel a stronger acid from one of its salts in solution, without any substance separating from the solution? For these experiments, they used benzoic acid for the weaker and nitrobenzoic acid for the stronger acid. They are both monobasic, are easily obtained pure, are easily separated from each other and from their salts, and can be recognized with certainty. They differ only, apparently, in the strength of their chemism. In the qualitative experiments, barium nitrobenzoate and free benzoic acid were dissolved in a large excess of water, the solution being heated to 80° C. After cooling to 14–17° the solution contained not only the substances originally dissolved, but also free ni-

* Zeitschr. Chem., 1866, 641.

trobenzoic acid and barium benzoate. The nitrobenzoic acid set free in the reaction, together with the benzoic acid also present, was dissolved by agitation with chloroform or benzol, in which the barium salt is insoluble. In the residue, after the solvent was distilled off, the presence of nitrobenzoic acid was proved by means of sodium. In a qualitative experiment, 1·6592 grams pure barium nitrobenzoate was mixed with the theoretical quantity, 1·1815 grams, of pure benzoic acid and dissolved in an excess of hot water. The cold solution was agitated with chloroform, the latter removed with a pipette, the solvent distilled off, and the residue freed from benzoic acid by a current of steam. The nitrobenzoic acid thus obtained was pure, and weighed 0·2341 grams, being 19·81 per cent of the acid contained in the barium salt used. Additional experiments seemed to show that the quantity of the stronger acid thus set free is dependent on the quantity of the weaker acid present.—*Ber. Berl. Chem. Ges.*, viii, 466, April, 1875. G. F. B.

2. *On Iodous Chloride.*—BRENKEN has examined, in the laboratory of Lothar Meyer, the formation and properties of iodous chloride, ICl_3. It was prepared by passing dry chlorine over dry iodine, the former being in excess. It is purified by repeated sublimation in a stream of dry chlorine; and then appears as a lemon-yellow crystalline sublimate upon the walls of the tube. Contrary to the statements of the text-books, it does not fuse, even in an atmosphere of chlorine; but even at 25 C. it suffers dissociation into chlorine and hypoiodous chloride, which latter it is that fuses. Under an atmosphere of increased pressure, the dissociation took place at 67°, the constituents reuniting as the tube cooled. In a sealed tube, the decomposition requires a temperature of 86°. If two pretty strong tubes containing iodous chloride be sealed and heated to 70° or 80°, their contents remain yellow. But if now the point of one of them be softened in a gas flame, it will be blown out by the interior pressure, the dissociated chlorine will escape, and the fused brownish red hypoiodous chloride will be left on the walls of the tube. At a still higher temperature, the ICl_3 in the unopened tube dissociates. Closing the opened tube again, and cooling both tubes, the unopened tube contains the yellow iodous, the opened one the brown red hypoidous chloride ICl, which remains for a long time liquid. Experiments to produce a liquid chloride resulted negatively.

In the following paper, MELIKOFF gives the results of his attempts to determine the vapor density of iodous chloride. He concludes that this vapor at the temperature of 77°, and under one atmosphere of pressure, even in presence of an excess of chlorine, decomposes completely into hypoiodous chloride and chlorine.—*Ber. Berl. Chem. Ges.*, viii. 487, 490, April, 1875. G. F. B.

3. *On the Paraffins of Pennsylvania Petroleum.*—MORGAN, under Schorlemmer's direction, has made an examination of the normal hexane and heptane from Pennsylvania petroleum, to test the question of the presence of isomers. The normal paraffins were chlo-

rinated, and then converted into olefines by treatment with alcoholic potash. These olefines were treated with cold hydrochloric acid, each of them being thereby separated into two fractions, one of which dissolved in the acid, while the other did not. The latter fractions yielded secondary alcohols when suitably treated, that from the hexane being methyl-butyl carbinol and that from the heptane being methyl-pentyl carbinol. It hence appears that the derivative olefines are normal, and have the constitution $CH_2{=}CH{-}C_nH_{2n+1}$. The former olefines, i. e., those soluble in hydrochloric acid in the cold, yielded alcohols which appeared to be secondary, but which need further investigation.

In some remarks upon this paper, SCHORLEMMER says that the above results do not necessarily prove the presence of a third isomeric heptane in petroleum. Heptane when treated with chlorine yields one primary, and may yield three secondary chlorides. If the heptenes from two of these combine with hydrochloric acid in the cold, the alcohols from them would yield on oxidation ethyl-butyl ketone and dipropyl ketone. These on further oxidation would yield propionic and butyric acids. Since Morgan obtained the latter, and as the acetic acid he obtained came probably from the presence in his heptane of a lower-boiling isomer, it is probable that, owing to the method he employed, the propionic acid was overlooked. To decide the question an absolutely pure paraffin is necessary; and the author proposes to make additional experiments with hexane from mannite.—*J. Chem. Soc.*, II, xiii, 301, April, 1875. G. F. B.

4. *Action of Ammonium chloride on Methyl alcohol.*—WEITH has satisfactorily shown that when ammonium chloride is heated with a sufficient excess of methyl alcohol, it is completely converted into methylamine chlorides. In one experiment two grams NH_4Cl and 12 c. c. $CH_3(OH)$ were heated together in a sealed tube to 280–285° for ten hours. No deposit appeared in the tube on cooling, the liquid existing in two layers. On opening the tube the lighter layer disappeared as a gas, which was proved to be methyl ether $(CH_3)_2O$. The remaining liquid did not contain a trace of ammonium chloride. It was distilled with barium hydrate, the distillate being collected in alcohol and examined. No trace of methylamine or of dimethylamine could be detected. The residue from the evaporation of the alcohol, treated with platinic chloride, gave pure trimethylamine chloroplatinate. Pushing the distillation still further, alkaline vapors were evolved, and the solution afforded on examination tetra-methyl-ammonium chloride. Quantitative experiments showed about 8 per cent of the NH_4Cl was converted into the tertiary base; the rest yielded tetra-methyl-ammonium chloride. Ethyl alcohol acts differently, scarcely a trace of amine resulting.—*Ber. Berl. Chem. Ges.*, viii, 458, April, 1875. G. F. B.

5. *On Glyceryl ether.*—This ether, first discovered by Linnemann and von Zotta, is prepared by dehydrating glycerin by means of calcium chloride. VON ZOTTA has re-investigated the

conditions of its formation. To prepare it 300 grams of dry glycerin were heated to 190° with 45 grams calcium chloride in a balloon of 900 c.c. capacity, until it frothed nearly over. The distillate, freed from the more volatile matters, was agitated with ether, which was removed and evaporated. It left about 22 grams of a product boiling between 150° and 240°. The glycerin was again treated in the same way, so that finally it yielded about ¼ its weight of a product boiling between 160° and 210°. This was agitated with potassium hydrate solution to remove the phenol, and rectified. Pure glyceryl ether was thus obtained boiling between 171° and 173°. Treated in this way 14·8 kilos. of glycerin yielded 250 grams of pure glyceryl ether and 18 grams of pure phenol. Glyceryl ether $(C_3H_5)_2O_3$, is an oily liquid miscible with water, alcohol and ether. Specific gravity at 16° is 1·16. On boiling its aqueous solution, it changes to glycerin. Treatment with bromine converts it into dibromhydrin. Solid potassium hydrate acts on it to produce phenol.—*Bull. Soc. Ch.*, II, xxiii, 310, April, 1875.

G. F. B.

6. *On the Purification of Salicylic Acid.*—The commercial importance now attaching to salicylic acid, makes it desirable to contrive a method for purifying it. The methods by which it is manufactured leave it strongly colored; and Kolbe's method for purifying it by converting it into ether, entails so much loss as to be practically useless. Since it cannot be sublimed without decomposition, alone, this method is impracticable; but RAUTERT has succeeded in subliming it completely in a current of superheated steam, and in this way readily obtaining it pure. Recrystallization from hot distilled water gave the salicylic acid in beautiful snow-white crystals.—*Ber. Berl. Chem. Ges.*, viii, 537, April, 1875.

G. F. B.

7. *On a New Method of Testing Quinidine Sulphate.*—HESSE proposes a new method of testing quinidine sulphate, founded upon the action of ammonia and water upon its iodhydrate, as compared with the iodhydrates of quinine, cinchonine and cinchonidine. Half a gram of the sulphate to be tested is warmed to 60° C. with ten cubic centimeters of water, half a gram of potassium iodide is added, well stirred, allowed to cool and after an hour, filtered. If the specimen was pure, the filtrate remains clear upon the addition of a drop of ammonia. If a precipitate is produced, quinine, cinchonine or cinchonidine is present. A less delicate test, but one commercially satisfactory, is as follows: Half a gram of the material is digested at 60° for about five minutes with 40 c.c. of water, and then mixed with three grams of potassio-sodium tartrate (Rochelle salt). If the specimen contains but little or no quinine or cinchonidine, the solution remains clear; if not, a precipitate appears, when the admixture amounts to six per cent. This precipitate, after standing an hour, is filtered off, washed with a little cold water, and the filtrate after warming is mixed with half a gram of potassium iodide. If quinidine be present, a precipitate of quinidine iodhydrate is produced. In

this case, the liquid is allowed to stand an hour, filtered off, and a drop of ammonia added to the filtrate. A precipitate indicates the presence of cinchonine, in amount at least two per cent. The presence of calcium and sodium salts in the quinidine sulphate is readily detected by solution in chloroform when these are left behind. If quinine or cinchonidine are also present, one gram of the substance is to be treated with seven cubic centimeters of a mixture of two volumes chloroform and one volume 97 per cent alcohol.—*Liebig's Annalen*, clxxvi, 322, May, 1875. G. F. B.

8. *Mechanical Equivalent of Heat.*— M. H. J. Puluj has devised an apparatus of very simple construction for measuring this constant, suitable for use in the lecture-room. It consists of a calorimetric and dynamometric portion, suitably connected with an oscillation machine, such as is found in every physical cabinet. The calorimetric part is formed by two hollow truncated cones of cast-iron, one fitting into the other, the inner not quite reaching to the bottom of the outer, and appearing a little outside of it. The outer cone can be fixed coaxially in the vertical bobbin of the machine. The inner cone contains mercury. If the machine is put in motion and the inner cone fixed, heat is generated by the friction of the surfaces.

An arrangement which is an inversion of Prony's check serves for the measurement of the work which is converted into heat. On the wooden lid of the inner cone a light wooden beam is screwed horizontally. A perforation passing through the beam and lid receives the thermometer. At some distance from the beam is a fixed pulley, on a level with it, over which a thread, to which a scale is suspended, is slung and is fastened to the end of one arm of the beam; the other arm serves as a counterpoise. When the machine is set in motion, the interior face of the outer cone rubs against the surface of the inner one and tends to turn the beam, which is fastened to the latter, in the direction of the motion. With a certain load the horizontal part of the thread and the axis of the beam will include a right angle. From the length of the beam-arm, amount of the load and number of rotations, the work converted into heat, and from the water value of the calorimeter and the rise of temperature, the quantity of heat generated, can be calculated.

The memoir contains also the development of the theory of the apparatus, taking into consideration the heat radiated from the calorimeter, and finally the numerical calculation of the values of the mechanical equivalent of heat from 28 experiments. The mean of the results, the 425·2, with the mean error $\pm 5{\cdot}4$, is in excellent accordance with Joule's result, 424·9, and may be regarded not only as a fresh corroboration of it, but also as a measure of the accuracy with which the experiments can be conducted by means of this simple apparatus; these occupy but very little time, an experiment proper lasting but 30–60 seconds, on which account the apparatus may be recommended for lecture-experiments.—*Roy. Acad. Vien.*, April, 1875; *Phil. Mag.*, xlix, 416. E. C. P.

9. *Action of Magnets on Geissler Tubes.*—M. J. CHAUTARD has studied somewhat at length the effect of a magnet on rarefied gases enclosed in capillary tubes, illuminated by an induced current. The gases or vapors employed were H, N, O, CO_2, CO, C_2H_4, S, Se, I, Br, Cl, SO_2, SiF_4, $SnCl_4$. Bodies of the chlorine family are those which gave the most concordant and brilliant effects. An increase of temperature diminishes the action of the magnet. This is shown by allowing the current to pass for some time, when the magnetic influence is enfeebled or destroyed. The presence of the gas is an important element to be considered, as by varying it the current may be intercepted or the appearance of the light greatly altered. Similar effects are attained by varying the strength of the current, and are most marked when the current is feeble. The phenomena are the same whether a Holtz machine or coil are used as a source of electricity, and are independent of the direction through the coil or gas. The form of the armatures is important; they should be plain and surround the tube for the greater part of its length. The effect of a single pole is slight, or of both poles when more than five millimeters distant from the tube.

The stoppage of the current by the magnet was shown by using two tubes, one of which was greatly narrowed and placed between the poles. As long as the magnet did not act the current passed through both tubes, but on closing the circuit the light was immediately extinguished in the narrow tube. This experiment succeeds best with Cl, I, S and Se. The cessation of the light occurs in two distinct cases, when the pressure is so slight that the current will scarcely pass, or when it is sufficient for the spark to attain nearly the same limit. Under the action of the magnet the luminous thread undergoes a contraction sometimes visible to the naked eye. An alteration in the color or in the spectrum is sometimes thus produced. This effect is scarcely perceptible with H, N and CO_2. The narrowing does not extend more than a few millimeters from the poles, so that with a tube of sufficient length we can, by varying the position of the spectroscope, view first the normal spectrum, and then that due to the magnet. The change is most marked with Cl, Br, $SnCl_4$, SiF_4, SO_2. Direct measures have shown that with these gases the new rays thus developed are wholly distinct from those characterizing the normal spectrum of the same gas.—*Comptes Rendus*, lxxx, 1161. E. C. P.

10. *Effect of Electricity of high tension on Liquids.*—M. G. PLANTE has applied his secondary pile to the study of these phenomena. The gradual diminution of the current, instead of being an objection, has the advantage that, without changing the other conditions, it enables us to study the effect of currents of every strength less than that first employed. Two batteries, each of twenty cells, were charged and connected with a wire 80 cms. in length, and 1 mm. in diameter. A voltameter was also placed in the circuit with electrodes of platinum wire, the positve wire only being immersed. When the negative electrode was placed in the liquid, a sheath (*gaîne*) of light was produced around it,

without sensible disengagement of gas; the other electrode set free a little gas, and the wire was not heated to redness. After two or three minutes, however, the sheath of light disappeared, gas was set free abundantly at both electrodes, and the wire at the same instant was heated to redness. To show these effects still better, ten batteries were used, equivalent to 300 Bunsen cells, connected for tension and capable of heating to redness a platinum wire 10 meters in length and 3 mms. in diameter. These batteries are charged by two Bunsen cells in the course of an hour. Repeating the above experiment with them, the wire, on touching the liquid, fused or volatilized with a flame variously colored, according to the metal employed. If the liquid merely contained traces of acid, so as to avoid complete fusion of the metal, a continuous series of sparks were produced with a noisy crackling like the discharges of an induction coil, and lasting sometimes several minutes. The most remarkable effect was obtained with a saturated solution of common salt. The voltameter being so mounted that the wires could be very gradually immersed, the negative pole was first plunged in about a millimeter, and the positive terminal then made to touch the surface. A small luminous and perfectly spherical globe then formed around it with a loud rattling noise; raising the wire, it increased in size until it had attained a diameter of nearly a centimeter, and then, on lowering the wire, began to revolve rapidly. After attaining a certain speed, it detached itself as if attracted by the other electrode, and disappeared with an explosion and flame at the negative pole. This globule is not gaseous but liquid in a speroidal state, illuminated by the current it transmits. If instead of immersing the wire it is brought near the glass sides of the vessel, a bright flash of a curved or zigzag form darts over a distance of three or four centimeters to the electrode, with an explosion as before. Soon after another spark is formed, and so on for several minutes. These luminous balls present a marked resemblance to, and offer a probable explanation of, the curious phenomena known as globular lightning. The cloud and earth form the electrodes, and the moist air replaces the liquid. Probably the balls, in the case of lightning, are not liquid, but are formed of ponderable matter charged with electricity. These experiments suggest the probability, if it is ever possible to try the experiment, that balls of lightning are charged with positive electricity.—*Comptes Rendus*, lxxx, 1134. E. C. P.

II. Geology and Natural History.

1. *Greenland Glaciers: Subglacier rivers.*—Prof. Nordenskiöld travelled thirty miles inland on the Great Greenland glacier and found its surface there to be only 2,000 feet above the sea, showing that the land over the interior must be comparatively low—and much lower than the islands bordering it, which average 2,000 feet in height In summer, the snow which covers the glacier melts and rivers of ice-cold water flow over the surface and

descend in the crevasses to unknown depths. These crevasses are exceedingly numerous, and apparently increase in number on passing toward the interior, where not a plant, or stone, or patch of earth is seen over the great ocean of ice and snow, 1,200 miles in extent from north to south and 400 in breadth. Dr. Rush believes that the outpour of the Greenland precipitation of snow and rain in the form of glacier ice amounts to only two inches, while he estimates the fall at twelve inches; so that, as the evaporation must be very small, a large portion of the remaining ten inches must be carried off by subglacier rivers.—"Nature" of April 8th, from which these notes are taken, has a geological map of the Arctic region between the meridians of longitude 20° W. and 80° W., prepared by Mr. C. E. De Rance, the author of a series of papers on the Arctic regions, in the same Journal.

2. *Bulletin of the U. S. Geological and Geographical Survey of the Territories:* Nos. 2, 3 and 4, second series. 68 pp. 8vo, with maps and plates. Washington, May 15th, 1875.—The papers contained in number 2 are: Monograph of the Genus *Leucosticte* of Swainson, or gray-crowned purple Finches, by ROBERT RIDGWAY; the Cranial and Dental Characters of Geomydæ, by Dr. ELLIOTT COUES; Relations of Insectivorous Mammals, by T. GILL; on the Natural History of the U. S. Geological Survey of the Territories for 1874 (a list of the Mollusks), by ERNEST INGERSOLL. Number 3 contains the following papers: Means of Communication between Denver and the San Juan Mines, by A. D. WILSON; on the Mines and Geology of the San Juan Country, by F. M. ENDLICH; on the Topography of the San Juan Country, by F. RHODA; on some peculiar forms of erosion in Eastern Colorado, with heliotype illustrations, by F. V. HAYDEN. No. 4 contains reports on the features of the Colorado or Front Range of the Rocky Mountains, by F. V. HAYDEN, with a number of plates; on the Tertiary Physopoda of Colorado, by S. H. SCUDDER; on a Natural Arrangement of the Falconidæ, by R. RIDGWAY.

Mr. Endlich, in his remarks on the San Juan Country, states that for more than 4500 square miles, the surface is covered continuously with volcanic rocks. The following succession of strata was observed: (1) 800 feet of trachyte, mostly light-colored; (2) 1200 feet of red to brown trachyte, containing sanidite and some mica; (3) 2000 to 2250 feet red to brown trachyte; (4) 3000 to 4000 of trachyte of various characters, making in all a thickness of 7000 to 8000 feet. Above follow doleritic beds.

The veins of the region, affording argentiferous galenite, sphalerite, tetrahedrite, brittle silver, etc., and some of them gold, occur in the trachyte, and are referred to the Cretaceous or the beginning of the Tertiary, the era of the trachytic eruptions.

Going south and west the volcanic strata thin out, revealing the rock they overlie. Near the head of Cunningham Creek the volcanic rocks form the crests of ridges, while the valleys cut through into metamorphic rocks, which are quartzyte, chloritic rocks, mica schist, staurolitic schist, gneiss, and a coarse-grained granite.

The plates illustrating the brief reports of Dr. Hayden are excellent.

Among the results of the same expedition, under the Interior Department, there have recently appeared also—(1.) A "Preliminary map of Central Colorado," showing the region surveyed in 1873 and 1874; Primary triangulation by G. T. Gardner, topography by G. R. Bechler, H. Gannett, A. O. Wilson and S. B. Ladd.

(2.) A colored Geological map of the sources of the Snake River with its tributaries, and of portions of the headwaters of the Yellowstone, by G. R. Bechler, topographer, and Frank H. Bradley, geologist.

(3.) A colored Geological map of part of Montana and Wyoming Territories, embracing most of the country drained by the Madison, Gallatin and Upper Yellowstone Rivers; Geology by F. V. Hayden, assisted by A. C. Peale; drawn by H. Gannett from notes and sketches by A. Burck, chief topographer of the Yellowstone division. It has contour lines.

3. *Second Geological Survey of Pennsylvania*, 1874. Report "B." On the Mineralogy of Pennsylvania, by F. A. GENTH. With an Appendix on the Hydro-carbon Compounds, by S. P. SADTLER; 206 pp. 8vo. Harrisburg, 1875.—Dr. Genth has included in this volume the results of his long study of Pennsylvania minerals, with many facts obtained from others who have labored in the same field. The minerals are arranged according to the system adopted in Dana's Mineralogy, and under each species is given, in a few words, its chief characteristics, and then in more detail the description of the localities in the State. Dr. Genth has added also a large number of new analyses recently executed by himself.

Report "J." On the Petroleum of Pennsylvania, by HENRY E. WRIGLEY. With a map and profile of a line of levels through Butler, Armstrong, and Clarion Counties, by D. J. Lucas; also a similar profile along Slippery Rock Creek, by J. P. Lesley. 122 pp. 8vo. Harrisburg, 1875.—Mr. Wrigley treats of his subject in all its bearings, historical, geographical, geological and economical; his report will be found of great value by all interested in the subject.

4. *Report upon the Reconnaissance of Northwestern Wyoming, including Yellowstone National Park*, made in the summer of 1873; by Wm. A. Jones, Captain of Engineers U. S. A. 326 pp. 8vo, with numerous maps.—This volume consists of a General Report of the region explored by Captain Jones; an Astronomical Report, by Lieut. S. E. Blunt; a Geological and Archæological and Philological Report, covering 200 pages, by Prof. T. B. Comstock; a Report on Mineral and Thermal waters, by Surgeon C. L. Herzmann; a Botanical Report by Dr. C. C. Parry, and an Entomological Report by J. D. Putnam.

The Report of Prof. Comstock gives much information on the features and structure of the region, with details respecting the geysers and hot springs of the Yellowstone Park. The Lower

Silurian of the Primordial and Canadian periods was observed, and perhaps Upper Silurian beds, but no Devonian, the next strata overlying being Carboniferous; whether the Subcarboniferous is included he leaves doubtful. Above the Carboniferous come the Triassic, Jurassic, Cretaceous and Tertiary. A colored geological map of the region accompanies the Report.

5. *Report of Progress of the Mineralogical, Geological and Physical Survey of the State of Georgia for the period from Sept.* 1 *to Dec.* 31, 1874; by GEORGE LITTLE, State Geologist.—This Report of progress gives brief notices of some of the mines and ores of the State, with also accounts of valuable localities of marble, roofing slate, mica for stove doors and other utensils of economical value, with a notice of some of the localities of minerals. There are also analyses of limonite, dolomite, limestone, etc.

6. *Michigan, being condensed popular sketches of the Topography, Climate and Geology of the State;* by A. WINCHELL, LL.D., late Prof. of Geology, Zoology and Botany in the University of Michigan. 122 pp. 8vo. 1873. Extract from Walling's Atlas of Michigan.—This is a valuable résumé of the results obtained by Prof. Winchell in his investigations into the Topography, Geology, and Climate of Michigan. The volume is accompanied by four maps—one a topographical map with contour lines; the second a colored geological chart of Michigan prepared from the latest observations; and the other two climatological charts, giving the isothermal lines for spring, autumn, and the year.

7. *Analysis of Ægirite from Hot Springs, Arkansas;* by J. LAWRENCE SMITH.—The occurrence of ægirite at Hot Springs (Magnet Cove), Arkansas, was first noticed by C. U. Shepard in this Journal, vol. xxxvii (p. 407), for 1864. The following are the results of my analysis of the mineral:

Silica,	51·41
Alumina,	1·82
Peroxide of iron,	23·30
Protoxide of iron,	9·45
Lime,	2·03
Magnesia,	0·31
Soda, with *trace of potash*,	11·88
Titanic acid,	·13
	100·33

The specific gravity is 3·53.

8. *Second Appendix to Dana's Mineralogy;* by EDWARD S. DANA; 64 pp. 8vo. New York, March, 1875. (John Wiley & Son.)—The first Appendix to Dana's Mineralogy was prepared in 1872, by Prof. G. J. Brush. The present Appendix follows that after an interval of three years, and is intended to make the work complete up to 1875. It includes full descriptions of 92 mineral species announced as new since March, 1872, with also explanations of a considerable number of other names new to the science but not properly belonging to distinct species. It also embraces references to all mineralogical articles published in the many

Journals since the issue of the Mineralogy in 1868; these references are placed under the name of each species, to which the article relates, the species being arranged alphabetically. This Appendix is consequently an index to all the mineralogical literature of the past seven years. A list of mineralogical books and of important general memoirs covers the few opening pages.

9. *Mineralogical Contributions*, V., by Prof. C. KLEIN, in Heidelberg.—Prof. Klein has investigated with great minuteness the crystals of octahedrite (anatase) from the Binnenthal. He distinguishes four distinct types of forms, and shows that they are remarkable for their large number of planes. He also proves it to be very probable that the mineral from this locality which was described by Kenngott as wiserine is in reality octahedrite.

E. S. D.

10. *On the presence of Vanadium in rocks.*—Dr. A. A. Hayes, in a paper read before the American Academy of Sciences, Boston, in January last, states that he had detected vanadium in many rocks associated usually with compounds of phosphorus and of manganese. His mode of examination for the detection of vanadium is described in detail, but no complete analyses of any rocks are presented. The author proposes in a future paper to give a tabulated list of the rocks. He also states the occurrence of vanadium in the well water of Brookline, near Boston.

11. *Pseudomorph after crystals of Labradorite from Verespatak;* by G. TSCHERMAK.—Feldspar-like crystals occur in the quartz-andesite of Verespatak, Transylvania, which are pseudomorphs after labradorite. Their form, however, is in many cases well retained, though the luster of the planes is gone. They were found to be twins in all cases, the several laws of twinning being similar to those often observed in orthoclase. Sometimes the crystals are very complex, being made up of a number of individuals. They have a snow white or sometimes yellowish color and earthy fracture, and though firm in the fingers are easily ground in the mortar to a soft, white powder. An analysis gave Sipöcz:

$\dot{S}i$ 55·96, $\dot{A}l$ 31·34, $\dot{F}e$ 1·16, $\dot{M}g$ 1·73, $\dot{C}a$ 0·65, $\dot{N}a$ 0·18, $\dot{K}a$ 4·96, $\dot{H}$ 5·41=101·39

Under the microscope the mass is seen to consist of two kinds of minerals in fine scales: one colorless, the other slightly greenish and having the appearance of a potash-mica, to which it is referred by Tschermak. Deducting from the above analysis the latter, which amounts to about one-fourth of the whole, and also deducting some unchanged feldspar, limonite, etc., present in small quantities, Professor Tschermak finds that the remainder corresponds to the formula, $3\dot{S}i, \dot{A}l, \dot{H}$, which he regards as expressing the composition of the colorless scaly mineral referred to, it being thus a hydrous alumina silicate differing from kaolinite. The change which has taken place in the original material consists essentially in an exchange of potash for soda, and of water for lime. This loss of lime has been often observed in other similar cases.—*Tsch. Min. Mitth.*, 1874, iv, p. 269.

E. S. D.

12. *Fungi; their Nature and Uses;* by M. C. COOKE, M.A., LL.D., edited by Rev. M. J. BERKELEY, M.A., F.L.S.—*The International Scientific Series.* Appleton & Co., New York. 1875. pp. 299.—The earlier volumes of the International Series which have come under our notice were so excellent, that it may not be reasonable to expect all their successors to come up to the same standard. Moreover, in such a treatise as the present, we are not to look for any substantial addition to our knowledge, but rather for a good popular exposition of what is already known in the science, including the interesting and important discoveries of the last few years, much of which has not yet been made available to general students or amateurs, at least in the English language. A book upon this subject, at once plain, practical and scientific, but not over-technical, calculated to subserve the wants of students and gratify a general interest, was much wanted, and we may add, is in a good degree wanting still. The expectations which the honored name of Mr. Berkeley upon the title-page inspired are diminished by his prefatory announcement, that, although he had promised to write the book, he had been obliged, through ill health and manifold engagements, to turn over the work to Mr. Cooke; but that he had editorially read the manuscripts and the proofs, subjoining some notes. The volume is therefore substantially that of Dr. Cooke, although we may conjecture that the chapters on the uses and notable phenomena of Fungi owe much to the veteran English mycologist's store of information.

The important chapters on the nature, structure, reproduction and classification of Fungi are not so satisfactory; partly because the plan of the work breaks up and widely separates matters which must need be connected to give a clear idea of the life-history of any fungus; partly because too many topics are entered upon and dropped without adequate explanation, and too many technical terms are used without explanation; and sometimes, it would seem, from imperfect apprehension of German authorities used, perhaps only in translations and deceptive magazine extracts. At least one may infer, from some points in the treatment of the most interesting group of *Mucorini* and of the *Myxogastres*, that the author can hardly have read Brefeld's *Untersuchungen über Schimmelpilze*, although he refers to it.

"As the work is intended for students, the author has had no hesitation in repeating what has been stated in former chapters where it has been thought to prove useful." Our own opinion is that repetitions are specially to be deprecated in a text-book, and may always be avoided by a good arrangement and methodical treatment. The author, moreover, "has had no hesitation" in devoting more than half a dozen of the earliest pages of the volume to a discussion of such a vexed and wholly subsidiary question as that of the Schwendener hypothesis of the algo-fungal nature of *Lichenes;* and he pronounces confidently against it. This will hardly close the controversy, nor be of much use to the

student. More to the purpose would have been some account of the methods of study adopted by modern investigators who have recently given a new and deep interest to mycology. Useful as this volume must be, and full as it is of interesting information about Fungi, it does not altogether supply the long-felt want of an elementary text-book. A. G.

13. *Æstivation in Asimina.*—The æstivation was formerly thought to be valvate in all *Anonaceæ*. In the Genera Am. Bor. Or. Illustrata, vol. i, 1848, it is mentioned that the petals of each set are more or less imbricated in *Asimina*, as also in some other genera. The petals enlarge so much before and during expansion that the proper æstivation needs to be determined in young flower-buds. A subsequent examination of these, in *A. triloba*, showed that there was hardly any overlapping in an early state. Accordingly, in the later editions of my Manual, no exception to the ordinal character, "valvate in the bud," is alluded to. In the Genera Plantarum, Bentham and Hooker distinguish their two tribes, *Uvarieæ* and *Unoneæ* by the æstivation of the petals,—more or less imbricated in the former, valvate in the latter, to which they refer *Asimina*. Last spring I had an opportunity to examine, on the living plants and flower-buds of *A. grandiflora*, the species in which the exterior petals are most accrescent, and the interior perhaps least so, the one which most resembles *Uvaria* in the appearance of the blossoms. The sepals appear to be truly valvate. The outer petals are decidedly imbricated, their tips well overlapping in the order 1, 2, 3, in the early bud, and remaining so during the great enlargement; but down the sides they do not overlap, nor are their bases contiguous. The inner petals are remote in bud: moderately accrescent, they remain proportionally small, and from first to last do not come into contact, the margins above the middle becoming revolute in anthesis, while the base grows more and more deeply concave and papillose-ridged. This portion is frequented by thrips, or such-like insects, as also is the mass of stamens as soon as the anthers open. The flowers are proterogynous, the stigmas being early in good condition, the anthers discharging pollen only when nearly ready to shrivel and fall.

On examining good fresh flower-buds of *A. triloba*, in May, I find that the sepals are truly valvate at first, but separate more or less as the bud swells. The exterior petals, a little distant at their bases, very slightly overlap as they meet at the summit, while just below the margins become a little revolute. The interior petals are similar, but rather more distant at base, and rather less obscurely, yet very slightly, overlapping at the very tips. As they increase in size they slightly assume the imbricated position which becomes conspicuous in the outer petals.

I conclude that the tribe *Unoneæ* cannot be distinguished from the *Uvarieæ*, at least upon the characters assigned, and that the one kind of æstivation passes by gradations into the other.

A. G.

14. *Text-book of Botany: Morphological and Physiological:* by JULIUS SACHS, Professor in the University of Würzburg: translated and annotated by A. W. BENNETT, M.A., and W. J. THISTLETON DYER, M.A. 858 pp. large 8vo. London. (Macmillan.) —The third and fourth editions of Sach's German treatise, and Van Tieghem's French translation of the third, have been noticed in this Journal. In point of mechanical execution, the volume now under consideration compares very favorably with its predecessors, which have received high praise. The translation into English is based, like Van Tieghem's, on the third German edition, and one is therefore tempted to first compare English with French editing. Considered as a translation merely, the former is superior. It is very close, idiomatic, and as clear as the original. In some instances the selection of English words to convey the expression involved in a compound German word is most felicitous. Considered as an annotated revision, the English edition is inferior. The solid pages, for instance those devoted to *Tension*, remain as in the German, whereas in the French, skillful paragraphing has rendered the whole far easier of reference. The use of significant headings for the paragraphs has enabled Van Teighem also to give a synoptical table of contents of much value. It has been shown in a previous notice that Van Tieghem's table presents a clear and exhaustive outline of the whole work. Nothing more than a list of sections replaces this in the present volume. This lack, having been so well met by a French editor, is all the more apparent and regretable. With this our adverse criticism is exhausted. This conscientious translation is a valuable and timely gift to botanical students; that our American fellow students may be more ready to welcome it, we present a sketch of the work.

The Text-book is divided into three parts: General Morphology, Special Morphology and Physiology. The first treats of the nature and forms of cells, the formation of cells, the structure of the cells, their constituent parts and occasional contents. Tissues defined as aggregates of cells which obey a common law of growth are next considered with reference to their formation and forms. Three systems of tissues are fully described, epidermal, fibro-vascular bundles, and fundamental. Here are presented comprehensive studies of laliciferous and vesicular vessels, sap-conducting intercellular spaces and glands. The primary *meristem*, the uniform tissues made up of cells, all of which are capable of dividing, is next treated of in connection with the terminal *point* of growth. Here a somewhat confused terminology (Hanstein's) is introduced. Frequent cross-references to illustrations further on would have made this free from the ambiguity which now characterizes it. The fault lies, however, at the door of the German abstract of Hanstein's and Reinke's work. The outward shapes of plants, differences between structural members and working organs, and metamorphosis, come next. Most of this chapter is a literal translation of the least satisfactory portion of the third edition. Much of it has been rewritten in the fourth German, and for the better.

Book second is wholly devoted to special morphology and outlines of classification. The former is based on excellent abstracts of monographs and is most serviceable. The "outlines" are of little use to our botanists except as an illustration of what systematic botany would become if it were left to the physiologists. Already since this edition was written, Prof. Sachs has changed his system; and it is still in a state of unstable equilibrium, or want of equilibrium. There is hardly a more profitable task for a young botanist than the comparison of the systematic sections of Book Second with Dr. J. D. Hooker's appendix to the English translation of De Maout's and De Caisne's work. The former is by a physiologist, the latter by a morphologist. Vegetable Physiology is given in Book Third. The excellence of this digest is apparent on a hasty perusal. It becomes more obvious when the book is used with advanced students as a hand-book in daily work. From constant use of the German and French versions in the laboratory during the past year, by students of two grades, the present writer can give it honest praise. When it is supplemented by the Experimental Physiology of the same author, the laboratory is well equipped. Vegetable Physiology is treated of under the following heads; Molecular forces in the plant; Chemical processes in the plant; General conditions of plant-life; the Mechanical laws of growth; Periodic movements of the mature parts of plants, and movements dependent on irritation; the Phenomena of sexual reproduction; the Origin of species. In addition to the copious citations made by Prof. Sachs, the translators have given many references to memoirs now accessible to English students in translations or abstracts. It seems to have been the aim of the editors to render the work of the greatest value to botanical students who are unfamiliar with German. It is a great pleasure to commend this volume, most heartily, as a good translation of the German hand-book to advanced botanical students. G. L. G.

15. *Zur Abwehr der Schwendener-Bornet'schen Flechtentheorie* (Contribution to a refutation of the Schwendener-Bornet Lichen theory); by Dr. G. W. KOERBER. 30 pp. 8vo, Breslau, 1874.—In this essay Dr. Koerber, one of the first Lichenologists of Europe, has cast the weight of his authority against the theory which has received considerable currency, that Lichens are a compound of an Alga (the gonidia) and a Fungus (the hyphæ). He maintains, first, that the "nicht-gonimische," i. e., the hyphæ, and the lichens themselves are not Fungi, citing, in support of this proposition, the known chemical and other differences between the two, and the fact that many lichens are altogether destitute of hyphæ. He is curious to know how, on the theory of Schwendener, the formation of a thallus from the copulation of Fungoid hyphæ and an Alga can be explained. Secondly, he maintains that the gonidia of Lichens are not Algæ, because: 1, in true Algæ the gonidia never produce hyphæ, while this is of common occurrence in the spores of Lichens; 2, that if the contrary were true, it is strange that in every Lichen several types of Algæ are necessary for the production

of the Lichen, and still more strange that in nature these various Algæ occur without any further result; 3, because many forms of gonidia are not known to Algologists as such, because they have never been seen in a free state; 4, because the Lichen gonidia correspond in their forms only to those Algæ which reproduce themselves by division and not to those which propagate by sexual reproduction, the former process being only a physiological one common to many or all lower vegetable cells, and destitute of systematic value. The transformation of gonidia into zoöspores, "Schwärmzellen," observed by Famintzin and others, is regarded as a process also common to low vegetable cells. The so-called "asynthetic gonidia," i. e., those which occur without the thallus, are, he thinks, not algæ, but free lichen-gonidia. Thirdly, he maintains that lichens are not evidences of parasitism, because the gonidia are in no way debilitated, diseased, or destroyed by their contact with the hyphæ, but on the contrary derive from it nourishment and growth, and if this view were accepted, there would result, as Th. Fries had already observed, in Lichenographia Scandinavia, p. 8, an incredible double and mutual parasitism of hyphæ upon gonidia and of gonidia upon hyphæ.

In conclusion, Dr. Koerber gives his own views in regard to the anatomy of Lichens. He agrees with Schwendener that the gonidia are not produced from the hyphæ of the thallus, but regards the connection of the two as a simple process of nourishment. To account for the origin of the thallus he supposes that the hyphæ of a germinating spore need, for their perfect development, to come in contact with the form of gonidia belonging to their own species. He asserts that the spores of some Lichens, as in the genus *Sphæromphale*, which has muriform spores, do not produce hyphæ, but gonidia of the kind called microgonidia or leptogonidia; and finally suggests several different methods, according to which, in his opinion, the lichen thallus may be produced by asynthetic gonidia (soredia).

Dr. Krempelhüber, in a notice of this essay in *Flora* for March 11, observes that Koerber's hypothesis has not much better foundation than Schwendener's, with which it has much in common. If the observations in regard to the spores of species of *Sphæromphale* are confirmed, he thinks them against Schwendener; and that, if Koerber's arguments and observations are not conclusive against Schwendener's hypothesis, they tend to render it still more improbable.

On the other hand, in *Flora* for March 21, 1875, Dr. George Winter, in a paper entitled "Zur Anatomie einiger Krustenflechten" (On the Anatomy of some Crustaceous Lichens), disputes the assertion that some lichens are destitute of hyphæ, and gives the result of his investigations of *Secoliga abstrusa*, *Sarcogyne privigna*, *Hymenelia affinis*, and *Natrocymbe fuliginea* (which last he maintains is a Sphæriaceous fungus), and concludes that these Lichens possess undoubted hyphæ, differing in no respect from those of other Ascomycetæ, and that his observations go to confirm Schwendener's theory. His investigations are to be continued. H. W.

16. *Gustave Thuret* died suddenly of angina pectoris, on the 10th of May, at his residence at Antibes, in the South of France. We judge that he had reached the age of about 65 years. He was one of the best investigators of *Algæ*, and the discoverer of their antheridia in the *Fuci*, as well as of their phenomena of fertilization. His earliest papers were published in 1840; the most important ones followed a few years later. His researches were kept up to the last, and much was still expected from him, although he was slow to publish, being extremely conscientious and critical. He ought also to be commemorated for his services to horticulture. The garden which he established upon his grounds in the vicinity of Antibes is most remarkable. Perhaps no public collection has a greater number of species growing in the open air; it is certainly unequalled in *xerophilous* plants,—to use the name recently applied by DeCandolle to those which affect arid regions. A visit to this collection at the proper season, under the genial and accomplished founder's guidance, was a treat long to be remembered. The loss by M. Thuret's unexpected decease is most serious. A. G.

17. *An Inquiry Respecting the Reversion of "Thoroughbred" Domestic Animals;* by WILLIAM H. BREWER of New Haven, Conn. (From the Proceedings of the American Association for the Advancement of Science, Hartford meeting, 1874.)—* * * I need not try to prove (what all will admit) that in our most celebrated breeds, their special excellences are the accumulated improvement of many successive generations, and that this improvement is often accompanied with marked and important changes of form and structure. Now, as this improvement and change are unquestionably the results of man's care, it is often stated that if the care be withdrawn, then the breed will retrace its steps, and go down by the same road that it came up (only vastly faster, the downhill road being the easier travelled), and become again what it sprang from, or to use the more familiar phrases which are supposed to sound more scientific, it "*reverts*" or "*returns to the original type.*" This has been said so often that it is believed, and with a great class of scientific men has become a dogma, and as such is used to sustain certain theories regarding the permanence of "original types," and the fleeting nature of "acquired characters." As a dogma, it finds a place in the lectures of eminent scientific men, and also in our scientific literature, and in the papers read before our learned societies, and from these high authorities it spreads and descends through various channels until at last it is proclaimed by the popular lecturer or finds a lodgment in the "agricultural column" of religious weeklies. * *

At the last meeting of this association, this dogma of reversion was strongly insisted on in one of the papers, and I find on p. B, 404, of the last volume of its "Proceedings," this: "The hog has been greatly changed by domestication, and yet, when left to himself, he soon returns to the original type. During the late war

some of the most improved breeds were turned loose and left to shift for themselves. *Three years after, I found them possessing all the physical characters of the wild boar of Europe.*" I have *italicized* in the quotation the special point to which I wish to call attention. At the reading of this paper the author verbally stated that a similar fact had been observed with "Durham cattle." About the same time the same dogma was strongly and publicly affirmed by another scientific authority who is even more eminent. In both cases the dogma was used as an argument to sustain a certain scientific hypothesis, or else to combat another hypothesis.

Now let us turn to another meeting, held scarcely a month after our last one. A herd of short-horns was to be sold at New York Mills, and stock-breeders flocked from near and far to attend this other meeting. They came from England, they came from California, they came from half the States of the Union; they even came from the very regions where these scientific authorities had but just told them that short-horns were so prone to return to their original type. There was less talk at that meeting than at the scientific one; the speeches were in fact *very* short, but they were to the point. The principal speaker was the auctioneer. He was doubtless eloquent in his way, but his eloquence alone will hardly explain the result; for in thirty minutes from the time he began, the sales amounted to a quarter of a million of dollars, and in a very short time, those reckless men, unheeding the warnings of their scientific brethren, bought one hundred and nine head of cattle for $382,000, an average of more than $3,500 per head. For the best five cows (belonging to a particularly excellent strain called the "Dutchess") they paid an average of $31,640 per head. *These prices indicate the faith of those men in the future permanence of the acquired characters of that herd.*

For some years I have been looking for the proof of the oft-repeated assertion, that thoroughbred stock of old and well established breeds ever returns to the original type (whatever that may mean), *under any conditions or circumstances.* Thus far the results have been entirely negative, that is, I often hear the general assertion, but I have not yet found the proof in scientific cases. Until within the past year, however, my inquiries have been verbal, as I had opportunity, and I kept no record of the answers received, because I thought that among practical men (so-called) the thing was settled. But the confident assertions within a year, by eminent authorities, that *such reversions would always take place under certain conditions*, and then, following so closely on the heels of these assertions, the remarkable sale of which I have spoken, have awakened a new interest in the subject, and I have resumed the inquiry, in the hope that, if there be any such great law, we may somewhere find the proof in specific examples. * *

I have therefore prepared the circular which follows, and I ask of the members any aid they may be able to give.

I append a copy of the circular, and I propose to give this association the further results of the inquiry at some future meeting.

"*Dear sir:* Will you have the kindness and patience to answer me the following questions:

1st. Have you, personally, ever known any case where *thoroughbred* short-horn cattle, because of climate, poor feed, neglect, or any other cause, have become in character anything else than short-horns—in other words, *where from any cause thoroughbred short-horns have degenerated into animals of any other breed or type?*

2d. Do you personally know of *thoroughbred* animals of any other breeds so changing or "reverting?"

3d. Have you ever heard of such a thing taking place in the experience of other breeders, so well authenticated that you believed it to be a fact?

Now please let me explain why I trespass on your time and good nature with questions that may seem to you to be simply absurd.

I think that the practical breeders of thoroughbred stock (of whatever kind) commonly believe that so long as the breed is kept pure and no other blood mingled, that although the animals may vary greatly in excellence, all of them will have the essential characters which distinguish that breed from all other breeds or "types."

On the other hand, many persons (who are not breeders of thoroughbred stock so far as I know) have asserted that if neglected, any breed will "revert to the original type," or by other words or phrases have carried the idea that, under such or other circumstances, the breed will not only lose its better qualities, but, moreover, that the animals will become of some *other breed or type* which is said to be that of the early and cruder ancestors from which the breed originally sprung, however long ago that may be. * * * * * *

That *grade* animals often "revert," that curious freaks and "sports" often attend violent crossing (and also that breeds *deteriorate* under bad management or bad conditions), are well enough known, but these facts do not effect the specific questions asked where *the blood is supposed to be kept strictly pure.*

18. *Seventh Annual Report on the Noxious, Beneficial, and other Insects of the State of Missouri*, made to the State Board of Agriculture; by CHARLES V. RILEY, State Entomologist.—This is a very sensible report, by one of the best entomologists of the country. It gives a large amount of valuable information about various noxious insects of Missouri, and other parts of the country, and advice as to the best means of checking their ravages. Among the insects treated of, the first noticed is the Colorado potato beetle, which, the Report says, originally fed on the *Solanum rostratum* Dunal, of the Rocky Mountains, but had in 1859 reached a point 100 miles west of Omaha; in 1861 invaded Iowa and Southwest Wisconsin; in 1864, 1865 crossed the Mississippi to Western Illinois; in 1866 occupied the region west of a line from Chicago to St. Louis; in 1867 reached Southwest Michigan and

West Indiana; in 1868 had entered Ohio, and in 1874 arrived on the borders of the Atlantic at many points. Another insect treated of is the Chinch-bug (*Micropus leucopterus* Say), which attacks the grains and grasses, whose ravages among the wheat, and corn, and oats of Missouri in 1874 caused a loss to the State, according to the author, of *nineteen millions of dollars*. A third kind is the Rocky Mountain locust (*Caloptenus spretus* Thomas), which has been recently so destructive; and others are the *Philoxera*, the enemy of the grape vine, the *Chrysobothris femorata*, an apple-tree borer, and *canker worms*. The articles are illustrated by excellent figures, and a map shows the path of the locust invasion of 1874 over Missouri.

III. Astronomy.

1. *The Transit of Venus, Dec.* 8, 1874.—In vol. ix of this Journal, at pages 157 and 234, has been given a synopsis of the principal stations at which successful observations of the late transit of Venus had been reported. As these reports for the Southern hemisphere were quite incomplete, we now present a fuller report from the principal stations of the Southern hemisphere. The stations are arranged in the order of latitude.

1. *Observations of the Transit in the Southern Hemisphere.*

(1.) Rodrigues, lat. 19° 4′, long. 4^h 14^m E. English station. Ingress and egress were well observed, and 441 photographic pictures were obtained.

(2.) Mauritius, lat. 20° 20′, long. 3^h 51^m E. Lord Lindsay's station. All the contacts were observed except the first, and 110 good photographs were taken.

(3.) Reunion, lat. 20° 51′, lat. 3^h 42^m E. Dutch station. Third contact observed, and a few photographs taken.

(4.) New Caledonia, lat. 21°, long. 11^h E. French station. All the contacts were observed except the third, and 100 good photographs were taken.

(5.) Windsor, lat. 33° 36′, long. 10^h 4^m E. English observatory The four contacts all observed.

(6.) Sidney, lat. 33° 51′, long. 10^h 5^m E. English observatory. Weather favorable. The four contacts were all observed, and 180 photographs taken.

(7.) Cape of Good Hope, lat. 33° 56′, long. 1^h 14^m E. English observatory. Both contacts at egress observed, and photographs taken.

(8.) Adelaide, lat. 34° 40′, long. 9^h 15^m E. English observatory. Last two contacts were well observed.

(9.) Melbourne, lat. 37° 49′, long. 9^h 40^m E. English observatory. All the contacts were observed except the first external, and 200 photographs were taken.

(10.) St. Paul Island, lat. 38° 43′, long. 5^h 10^m E. French station. Both the internal contacts were observed, and numerous photographs were obtained.

(11.) Campbelltown, Tasmania, lat. 41° 55′, long. 9^h 50^m E. American station. The second internal contact observed, and fifty-five good photographs were taken.

(12.) Hobart-town, Tasmania, lat. 43° 0′, long. 9^h 49^m E. American station. Thirty-nine good photographs were obtained, but no contacts were observed.

(13.) Christ Church, New Zealand, lat. 43° 30′, long. 11^h 31^m E. English station. Observations failed from clouds.

(14.) Chatham Island, lat. 43° 48′, long. 12^h 12^m E. American station. No contacts observed. Eight good photographs taken.

(15.) Queenstown, New Zealand, lat. 45° 0′, long. 11^h 15^m E. American station. First and second external contacts observed. Fifty-nine good photographs taken.

(16.) Kerguelen Islands, lat. 49° 54′, long. 5^h 41^m E. English, German, and American station. The Germans got both contacts at ingress and egress. The English and Americans observed the ingress, but not the egress. Twenty-six good photographs were taken by the American party.

(17.) Auckland Islands, lat. 50° 48′, long. 11^h 7^m E. German station. The sun was obscured till ten minutes after the beginning of the transit. From that time, the contacts were observed, and heliometer observations and photographs were obtained.

(18.) Campbell Island, lat. 52° 33′, long. 11^h 17^m E. French station. Venus seen before ingress only. No contacts observed.

2. First results from the Transit.

M. Puiseux has given the first French results for the sun's parallax, using the observations of Pekin and St. Paul, all made with object glasses of 216 millimeters (8½ English inches). The parallax is 8″.879. E. L.

2. *On the Solar structure;* by FATHER SECCHI.—Father Secchi has made a very full reply to the article by Professor Langley, "on the comparison of theories of solar structure with observation," published in the March number of this Journal, first by notes upon the communication as it appeared in the *Memorie degli Spectroscopisti* of Palermo, and in a lecture delivered to the Tiberine Academy, which was published in the *Voce della Verita*, which has been in part reproduced by him in a subsequent number of the *Memorie*, with additional remarks.

Father Secchi accepts, without reserve, the statements of the article in question so far as they embody facts of observation, and remarks, of the illustration, that it is the very truth, rendered in minute detail. As to the interpretation of fact, there is, however, he observes, more than one point of view, and this leads him to an exposition of his own. His views, as now presented, differ from those he was understood to hold till lately, and in their present form are of such interest that their outlines are here reproduced, as nearly in his own terms as is possible in such an abridgement.

Spots are due to eruptions of metallic vapors from the interior of the sun.—Three phases in the life of a spot may be distin-

guished: (1) That of its formation. (2) That of a subsequent period of relative calm. (3.) That of its closure and extinction. In the first the metallic eruptions attain their maximum violence; vortical motion on an enormous scale is visible both in the photosphere and in the chromosphere; in the former (to borrow an architectural term) *in plan*, in the latter *in elevation*. These vortical motions are a consequence, not a cause—products of the eruption, admittedly associated with the spot, but not generators of it. (It is this period which Mr. Langley has taken as the subject of his article, as shown by a history of the spots' appearance in the clear sky of Rome, in the days preceding and following those employed in its study at Allegheny.)

In the second phase the spot commonly presents a crater-like formation, an obscure central mass being invaded by convergent gaseous streams, which form the luminous bridges and filaments. The eruption now is comparatively gentle, or has nearly ceased, though new matter, still extruded, checks the invasion of the surrounding photosphere, and mingling with its insetting currents, causes the radiate appearance of the penumbra. This phase may be compared to that period in the eruption of the terrestrial volcano when the lava, which has risen to the tip of the crater, is being discharged without tumultuous outbursts, or the formation of the *pine* of smoke.

In the third phase, both of the terrestrial and solar volcano, the emission ceases and all is over.

We may now understand how it is that though every great eruption generates a spot, every spot is not seen accompanied by a chromospheric eruption. To the second and third epochs alone belong that condition of the nucleus, as a deposit of more or less stagnant matter, which Mr. Langley mistakingly assumes Father Secchi to suppose it to be in, generally. M. Faye and he have attacked Father Secchi from opposite sides, not perceiving that the latter's point of view is double—as it is. More than this (and however such critics may exclaim against the apparent contradiction), he affirms the possibility of a third thing, a sequence to Galileo's and Kirchoff's views, namely, that a spot may be generated from a cloud of metallic vapors above the photosphere, or resting on and partly immersed in it; it being by no means certain that the spot is always a cavity. Let us not impose our own artificial limits on greatly varied Nature!

P. Secchi concludes that Mr. Langley's observations, though undoubtedly exact and reliable, give little which he has not himself, in considerable part, anticipated, though they may be admitted to have carried the resolution of photospheric detail farther in some respects than he has been able to do, with the smaller aperture of the Roman instrument.

Mr. Langley's impression that the observations he brings do not accord well with Father Secchi's views, is altogether owing to misapprehension of the true nature of these; on the contrary, the article and illustration bring gratifying and remarkable confirma-

tion of Father Secchi's own observations, and on points where they have been called in question.

On the whole, then, while he must insist that longer study will modify the American observer's interpretation of the facts, he would rather be understood as admiring the Allegheny observations than as disputing them. X.

3. *Observations on Magnetic Declination made at the Trevandrum and Augustia Observatories.* Vol. I. Discussed and edited by JOHN ALLEN BROUN. London, 1874.—This volume is the first of the official publications of the extensive series of observations made since 1836, at Trevandrum, under the successive superintendencies of Mr. J. Caldecott and Mr. J. A. Broun. In it the author gives us the first installment of a series of volumes of magnetic observations made at the auxiliary observatory at Augustia, and the main establishment at Trevandrum during the years 1852 to 1869. In explanation of the latter date, it may be stated that although Mr. Broun departed from Trevandrum in April, 1865, yet he was so fortunate as to obtain the continuation for six years of the series of observations made by his two best assistants. He has himself, for the past ten years, therefore, resided in London, and superintended the discussion and editing of the series of volumes which are promised to the scientific world. In the present volume we have a *resumé* of most of the publications made by him during the past 30 years in the transactions of various scientific societies, which appear here as contributions to terrestrial magnetism from the Trevandrum Observatory. Pages 1 to 80 consist especially of descriptions of instruments, methods of observation and reduction, and narratives of the various explorations made into the neighboring country. Pages 80 to 184 give us the results of magnetic observations made with the improved instruments introduced by Mr. Broun, giving in fact a full, and often a new, discussion thereof, that adds materially to our knowledge of questions relating to the variations of magnetic declination. The chapter relating to the 26-day period, co-extensive with the rotation of the sun on its axis, is interesting, inasmuch as the author states that he has evidence, to be given at a future time, of a double oscillation of this period. Pages 192 to 448 give the individual hourly observations for every day of the year, with the declinometers established at Trevandrum, Augustia, Shertally, and Cape Comorin. Pages 453 to 570 are occupied with appendices, principally the annual reports of the director in reference to the observatories, the almanac, the public museum and other public duties which were imposed upon him.

The observatory at Trevandrum occupies the summit of a small hill, which is from 60 to 70 feet above the sea and within four miles of the shore. The observatory at Augustia was intended to be built at as great a height as possible, and at the same time as near as possible to the Trevandrum Observatory. Its altitude is accordingly found to be about 6,200 feet, and it is situated about 10 miles from the main station. The stations at Shertally and

Cape Comorin were occupied for a few months only in 1858 and 1859.

The appendices containing Mr. Broun's annual reports are very interesting reading, if for no other reason than as showing the tenacity with which he clung to his determination to carry out a series of most exact scientific observations in a region known only to a few savages and inhabited by ferocious animals. Every page gives us illustrations of the difficulties that he had to encounter both from the climate and the native assistants, and makes us wonder that he has accomplished so much. He certainly would not have been able to have accomplished what he has done had not his previous experience at the Makerstoun Observatory stood him in good stead. C. A.

4. *Determination of weights to be given to observations for determining time with portable transit instruments, recorded by the chronographic method;* by CHARLES A. SCHOTT. Appendix No. 12, U. S. Coast Survey Report for 1872.—In this little pamphlet Mr. Schott collects together the results of the general experience of the telegraph longitude parties of the Coast Survey for a number of years. He states that the introduction of the chronographer registration of transit of stars has considerably increased their precision, rendering it desirable to discuss the relative weights of the equations of condition. In the Coast Survey practice, two classes of portable instruments are employed for longitude purposes, the largest size having reticules of 25 threads, the smaller size having glass diaphragms of 15 lines. It appears from the probable errors deduced in Mr. Schott's paper, that for the larger instruments the gain in accuracy, between 17 and 25 threads, is very trifling, and probably more than counterbalanced by the increased fatigue of the observer, and consequent change in his personal errors; a diaphragm of 17 threads is recommended, which may be conveniently disposed in three tallies. The probable error of a transit over a single thread is found to be

for large portable transits $\pm\sqrt{(60{\cdot}063)^2+(0{\cdot}036)^2\tan^2\delta}$.
for small " " $\pm\sqrt{(0{\cdot}080)^2+(0{\cdot}063)^2\tan^2\delta}$.

In the reduction of the observations made during any one night for longitude purposes, it is recommended not to assume a constant azimuthal error, but to determine it before and after each reversal of the instrument. In general, the collimation, azimuth and clock correction should be determined independently, before and after each reversal. The criterion for the correctness of the entire work is found in the equality of the clock corrections as referred to the same moment of time. C. A.

5. *On the Meteorite of Lancé;* by DR. K. VON DRASCHE; Tschermak's Mineralogische Mittheilungen, 1875.—This meteorite fell near Lancé in July, 1872; it belongs to Rose's group called Chondrites. Dr. Drasche has given the results of a minute and careful microscopic examination.

III. Miscellaneous Scientific Intelligence.

1. *On the Height of the St. Louis Directrix;* by G. C. Broadhead. (From a letter to one of the Editors.)—I find that Mr. J. T. Gardner, in his determination of the height of the St. Louis directrix,* has omitted all reference to the careful observations of Dr. Engelmann, as given in vol. i, No. 4 of the Transactions of the Academy of Science of St. Louis (pp. 663–667), and quoted in the American Journal of Science, vol. xxx, p. 394 (1860). Humphreys and Abbot, in their work, bear testimony to the correctness of the observations of Dr. Engelmann. Dr. Engelmann and Mr. E. H. Barton, of New Orleans, carefully adjusted two barometers, compared them together, and then observed them for several months, one party being in St. Louis and the other in New Orleans. The result proved the elevation of the St. Louis directrix to be 404·9 feet above the Gulf. Mr. Gardner makes it 428·29 feet, a difference of 23·39 feet. Mr. Gardner's results are chiefly or altogether based on railroad levels. Now, if these railroad levels were run continuously from the Gulf up, they might be correct. But I have had much to do with getting railroad profiles, and have found that few of them can be relied on throughout. I have two profiles of one railroad 300 miles long in Missouri, and they widely differ; and one of these, the Missouri Pacific, claims to be correct. The profile notes of the Missouri, Kansas and Texas Railroad, from Texas to Sedalia, makes out a different elevation above the sea at Sedalia from those of the Missouri Pacific Railroad. There is not a railroad line in Missouri north of the Missouri River whose elevations can be relied on throughout. One railroad, of 150 miles long, has three or four breaks of elevations on it, each beginning at an assumed datum.

2. *Swedish Arctic Explorations.*—The Swedish Arctic Expedition to Novaya Zemlya, which will start at the beginning of next month from Tromsöe, will be occupied first with botanical, geological, and ethnological inquiries in the southern part of Novaya Zemlya, and then advance along the west coast to the northern point, which it expects to reach about the middle of August. Thence it will go to the northeast to explore this still quite unknown part of the Polar Sea, and then southward to the mouths of the Obi and the Jenisei, where the country is geologically very interesting. If the ice creates no obstacles, Prof. Nordenskiöld will here quit the vessel, and go in a boat up the river, to return home afterward by land.—*Nature*, May 20.

3. *Norwegian Exploration.*—The Norwegian Government has granted a credit of £4,000 for an expedition to be sent out next year under the scientific direction of Dr. Mohn, for the exploration of the sea between Iceland, the Faroe Islands, Spitzbergen, and Jan Mayen. The commander of this expedition will be Capt. Carr Wile, of the Royal Norwegian Navy, who is now in England gathering information as to the work done by the *Challenger*.—*Nature*, June 10.

* See this Journal, III, vol. ix, p. 309.

4. *British Arctic Expedition.*—The ships Alert and Discovery, of the British Arctic Expedition, sailed from Portsmouth on the afternoon of the 29th of May. The Valorous accompanies them to Disco.

5. *American Association for the Advancement of Science.*—The next meeting of the American Association will be held at Detroit, Michigan, in August, commencing on Wednesday, the 11th, at 10 o'clock, A. M. The headquarters of the association will be at the Russell House on Monday and Tuesday, and afterward at the City Hall and Court House, directly opposite. That the circular of the Local Committee may be received without fail by those intending to be present, word should be sent by each to Frederick Woolfenden, Esq., Detroit, Secretary of the committee. It is expected that the Chemical Sub-section, instituted at the last meeting, will be largely represented; and also, that the departments of Ethnology and Archæology will have a prominent sub-section established, to be called the sub-section of Anthropology. The president of the year is Mr. J. E. Hilgard, of the Coast Survey; the vice-presidents, Prof. H. A. Newton of New Haven for Section A, and Dr. J. W. Dawson of Montreal for Section B. Prof. S. W. Johnson of New Haven is chairman of the Chemical Sub-section.

The new volume of the Proceedings of the Association—that for 1874—has been issued. The volumes of the Proceedings, now twenty-three in number, can be obtained from the Permanent Secretary, F. W. Putnam, Salem, Mass., at the price of $1.50 a volume; or, if ten or more volumes are ordered, for $1.00 a volume.

6. *Milligrade Thermometric Scale.*—Mr. J. Williams, in a paper before the Chemical Society of London, proposes to substitute the freezing and boiling point of mercury for those of water, and to divide the scale into a thousand parts.

7. *Dr. Horace Wells.*—A bronze statue to Dr. Horace Wells of Hartford, Connecticut, "the discoverer of Anæsthesia," who died nearly a quarter of a century since, will soon be erected in Hartford. The statue is by the sculptor, Truman H. Bartlett. The State of Connecticut appropriated five thousand dollars toward the monument, and the city of Hartford an equal amount. The expenses of the pedestal of the statue, which should also be of bronze, are not met by these appropriations, and funds are solicited of the public by the Committee of the Hartford Medical Society, of whom Dr. E. H. Hunt of Hartford is chairman, and Dr. G. W. Russell of the same city treasurer. Dr. Wells was the world's benefactor.

8. *Report of the Superintendent of the Coast Survey for the year* 1871. 220 pp. 4to, with many maps.—Besides the general report on the progress of the survey, this volume contains a paper by G. Davidson and C. A. Schott, Assistants, on a comparison of the methods of determining heights by means of leveling, vertical angle and barometric measures from observations in California; reports by Assistants G. W. Dean and C. H. F. Peters, of obser-

vations of the total solar eclipse of Dec. 22, 1870; a report by C. A. Schott on the adaptation of triangulations to the various conditions of configuration and character of the surface of country and other causes; description, by J. Homer Lane, of a new form of mercurial horizon, in which vibrations are speedily extinguished. There is also a *General Index of professional and scientific papers contained in the Coast Survey Reports from* 1851 to 1870. The volume contains 36 large charts, and among these, under the head of River and Harbor Charts, there are charts of Plattsburgh, Burlington, New Haven, New York Bay and Harbor, Nos. 1 and 2, Delaware River from Navy Yard to Fort Mifflin Light-house, Neuse River, Passes of the Mississippi, Puget Sound.

9. *The Life and Growth of Language: an Outline of Linguistic Science;* by W. D. WHITNEY, Professor of Sanskrit and Comparative Philology in Yale College. 326 pp. 12mo. New York, 1875. (D. Appleton & Co.)—Prof. Whitney writes with the clearness, depth of insight and comprehensiveness of one who has full command of his subject in all its bearings and details. His word is an admirable exposition in a brief form of the science, growth, and, as far as can be reasoned out from known facts, the origin, of language.

10. *The Recent Origin of Man, illustrated by Geology and the Modern Science of prehistoric Archæology;* by JAMES C. SOUTHALL. 606 pp. 8vo, with many illustrations. Philadelphia, 1875. (J. B. Lippincott & Co.)—The author of this work has gathered into it a large amount of information on prehistoric man, and on the valley-formations, cave deposits, and other repositories of human relics. The attempts which have been made to measure time by means of the thickness of valley-formations, peat-beds and stalagmitic deposits are discussed, and sources of error pointed out; and the conclusion reached is that indicated in the title of the work. The facts are given with much detail and are illustrated by many figures. Unfortunately the author lacks in scientific knowledge, and therefore in ability to handle well the geological questions he deals with, and steer clear of his prejudices. His chapter on the fickleness of science shows great misapprehension of the subject. In fact, the whole work exhibits a temper toward scientific writers, and a consequent misunderstanding of men and opinions, which is calculated to repel any honest searcher for truth who is not already of the author's mind.

11. *Note sur les Tremblements de Terre en* 1871, *avec Supplément pour les années antérieures, de* 1843 *a* 1871; par M. ALEXIS PERREY, Professeur Honoraire a la Faculté des Sciences de Dijon. pp. 145. Bruxelles, 1875.—This constitutes Professor Perrey's twenty-ninth annual report presented to the Royal Academy of Belgium and is published in vol. xxiv of their *Memoires.* The first seventy-two pages are occupied with the supplementary report for the preceding years. In the remainder, constituting the report for 1871, the most noteworthy items are: Earthquakes in England, March 17; in Chili, March 25; in the Philippine Islands, May 1; and the eruption of Mauna Loa in August.

Etude du réseau pentagonal dans l'océan Pacifique, pp. 4, and *Sur les volcans de l'île de Java, et leurs rapports avec le réseau pentagonal*, pp. 3; par M. ALEXIS PERREY.—Two interesting and valuable papers presented to the Academie des Sciences at Paris on August 17 and November 9, 1874. C. G. R.

12. *Storms: their Nature, Classification and Laws, with the means of predicting them by their embodiments, the Clouds;* by WM. BLASIUS, formerly Professor of the Natural Sciences in the Lyceum of Hanover. 342 pp. 8vo. Philadelphia, 1875. (Porter and Coates.)—The author observes in his Preface: "I am convinced that the existing theories of the nature and laws of changes of weather are intrinsically erroneous, and that at least a much nearer approximation to the truth will be found in this volume."

13. *Climate and Time in their Geological Relations: a theory of Secular Changes of the Earth's Climate;* by JAMES CROLL, Geological Survey of Scotland. 578 pp. 8vo, with many illustrations. London. 1875. (Daldy, Isbister & Co.)—This work is a learned controversial discussion of some of the most difficult questions in geology and terrestrial physics, viz: the source of oceanic currents; the origin of changes of climate and the glacial epochs in geological history; the probable age and origin of the sun; a method of determining the mean thickness of the earth's sedimentary rocks; cause of the changing water-level in the earlier half of the Quaternary; the effect on climate of a change in the obliquity of the ecliptic; theories of glacier-motion and explanations of many glacial phenomena; nature of heat vibrations; the cause of regelation, and many other related topics. It is illustrated by several plates.

14. *English Men of Science, their Nature and Nurture;* by FRANCIS GALTON, F.R.S., author of Hereditary Genius, &c. 206 pp. 12mo. London, 1875. (New York, D. Appleton & Co.)—This work, already well known, is a valuable contribution to the subject of heredity, as well as to that of the history of science.

15. *The Aerial World. A popular account of the phenomena and life of the Atmosphere;* by G. HARTWIG, M. and P.D. 556 pp. with numerous illustrations. New York, 1875. (D. Appleton & Co.)—A popular and handsome work, full of interesting matter and for the most part good in its science.

16. *French Academy of Sciences.*—General Sabine has been elected a corresponding member of the Academy of Sciences,

OBITUARY.

JOHN EDWARD GRAY.—This veteran naturalist died on the 7th of April, at the residence in the British Museum which he has long occupied, and which, having recently retired from the keepership, he was about to vacate. Naturalists from all parts of the world have pleasant memories of the liberal but unostentatious hospitality there dispensed by Dr. Gray and his surviving consort, and will miss him at the Museum, which he has served most assiduously and ably for more than half a century. He was

Dr. Leach's assistant almost in boyhood, was officially connected with the Museum in 1824, when Mr. Children became keeper of the Natural History collections, and succeeded to the keepership of the Zoological collections in 1840, upon Mr. Children's retirement. The whole development of this noble collection has therefore taken place under Dr. Gray's superintendence. To it he brought a persistent ardor, indomitable energies, and great practical powers; and he worked unflaggingly down nearly to the close of the year 1869, when he was suddenly prostrated by paralysis. Even then his mental activity was hardly or briefly interrupted, although he lost the use of his right side, and his scientific contributions have continued to appear down even to the beginning of the present year. As some evidence of his activity, it may be mentioned that his contributions to scientific journals and transactions alone—as indexed in the Royal Society's Catalogue, had reached 500 in number in 1863, and his independent publications, before and since that date, are far from few. He published also upon penny postage and postage stamps, decimal coinage, prison discipline, sanitary reforms, the arrangement and utilization of museums, and many other topics. These were the bye-plays or recreations of a busy life; but he was pre-eminently a zoologist,—a typical zoologist of "the old Linnean school," and the last of the race. The biographical notices in the various English journals, most of them familiar to our readers, give good general views of the amount and character of his zoological work. He was also a botanist, and it was in this field that he entered upon his scientific career. In this department he was not of the Linnean school. For he wrote "the systematic part of the 'Natural Arrangement of British Plants,' the work that first introduced the natural system of plants to the student of English history." Although published in the name of his father, Samuel Frederic Gray, the son reclaimed it as his own, stating that he was responsible for all but the introductory portion. It was a very elaborate work for a young man, and several hands were probably engaged in it. But it failed of success, partly because it was not very well thought of by the leading botanists of Jussiæan school, and partly on account of a pitiful personal opposition on the part of the Linnæans, who subjected the young reformer "to something very like persecution." If Dr. Gray was "overgiven to controversy," perhaps this early ill-treatment may have fostered the disposition. When the Royal Botanical Society of London, which established the exhibitions and conservatories in Hyde Park, was founded, Dr. Gray accepted the presidency. In 1864 he published a neat little Handbook of British Water-weeds or Algæ. In 1865 he caused to be printed—as a matter of historical interest—a portion of Salisbury's manuscript "Genera of Plants" (pp. 143, 8vo, Van Voorst), which, with other MSS. and papers, was made over to him by Mr. Burchell's executor, after the death of the latter in 1864. Salisbury had bequeathed all his papers to Burchell, who made no use of them. Dr. Gray's in-

terest in reclaiming them, and in arranging for their preservation in the British Museum, grew out of memory of assistance rendered by Salisbury, who lent him these manuscripts when he was preparing the "Natural Arrangement of British Plants," and of former propositions of Salisbury, that he should devote himself to botany and edit any unpublished works that the latter might leave in manuscript. Dr. Gray declined the proposition, and with it tempting pecuniary offers. But, after forty years interval, he printed a "fragment of the Genera Plantarum, exactly as it was left by the author, for the purpose of showing the kind of work that he intended to produce."

Dr. Gray married, in 1826, the widow of his cousin, Francis Edward Gray, "a fitting helpmate to share and encourage him in all his undertakings," an excellent algologist and conchologist, a lady of remarkable powers and graces. A. G.

Admiral Sherard Osborn died on the 6th of May, in his 54th year. He entered the Royal navy in 1837, became lieutenant in 1846, and three years afterward was selected as a volunteer for the Arctic expedition sent in search of Sir John Franklin: again, in 1852, he took command of the Pioneer on a second extended Arctic expedition, having the same purpose in view. He was a member of the committee on equipments of the expedition which has just sailed.

Samuel Heinrich Schwabe, the astronomer, died on the 11th of April, in his 86th year. To Schwabe's observations on the sun's spots science owes the discovery of their periodicity, and that the length of the period was ten to eleven years.

A. G. Findlay, the geographer, and member of the Council of the Geographical Society of London, died at Dover on the 3d of May, in his 64th year.

M. Deshayes, Professor in the Paris Museum of Natural History, died on the 9th of June.

Joseph Winlock, Director of the Observatory of Harvard College, died suddenly on the 11th of June.

Sir William Logan, long at the head of the Geological Survey of Canada, died at Ontario, Canada, on the 28th of June.

Memoirs of the Geological Survey of India. Palæontologiæ Indicæ. Fauna of the Indian Fluviatile Deposits, vol. i, ser. x; I, Rhinoceros Deecanensis, by R. B. Foote, 18 pp., fol, with three plates.—Also vol. x, part 2, and vol. xi, pt. 1 of the Memoirs, and vol. vii, Parts 1 to 4 of the "Records" of the Survey.

Practical Hints on the selection and use of the Microscope, by John Phin. 131 pp. 12mo. 1875. New York. (The Industrial Publication Co.)—A small meager work, very inadequately illustrated.

A Brief Essay on Heat, Light, Electricity and Magnetism, by Charles Skelton, M.D. 75 pp. 8vo. Trenton, New Jersey, 1875.—The author, objecting to the present theories, makes light the rapid wave motion of imponderable matter; heat, this matter in excess in ponderable matter; electricity and magnetism, this imponderable matter in flowing currents.

Die Idee der Entwickelung; eine sozial philosophische Darstellung; von Leopold Jacoby. Erster Theil, 134 pp. 8vo. Berlin, 1874. (H. E. Oliven.)

What Young People should Know. The Reproductive function in Man and the lower animals; by Burt G. Wilder. 212 pp. 12mo, with 26 illustrations. Boston, 1875. (Estes and Lauriat.)

STORM OF MARCH 29. 1873 PLATE I

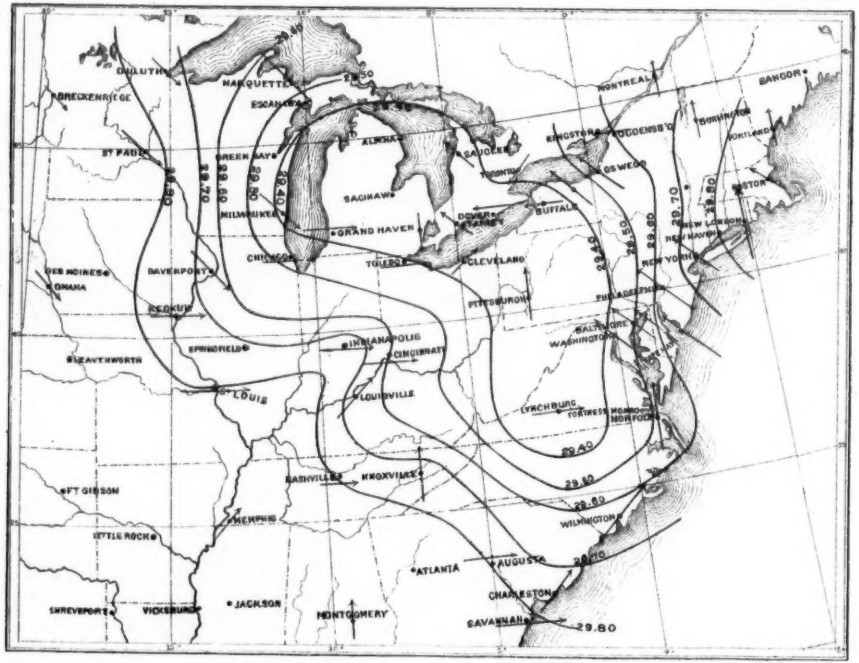


Fig. I

Fig. II

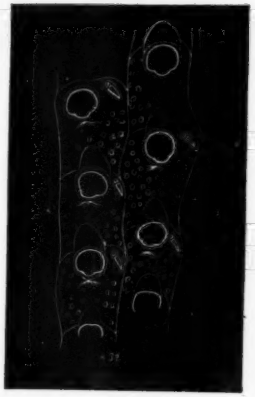
Author. del

PSEUDOMORPH AFTER GARNET.

J. Bien. lith

Remnants of Garnet. Chlorite. Magnetite & Discoidal Plates. Chlorite.

1



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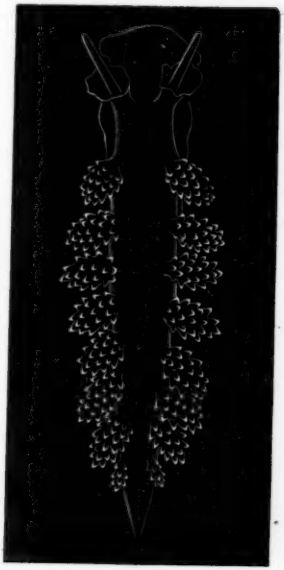

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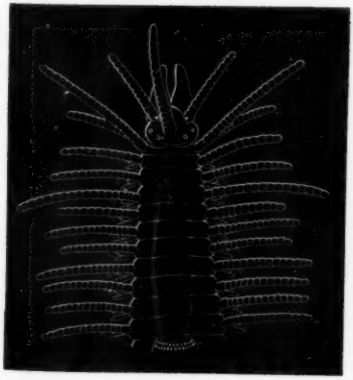

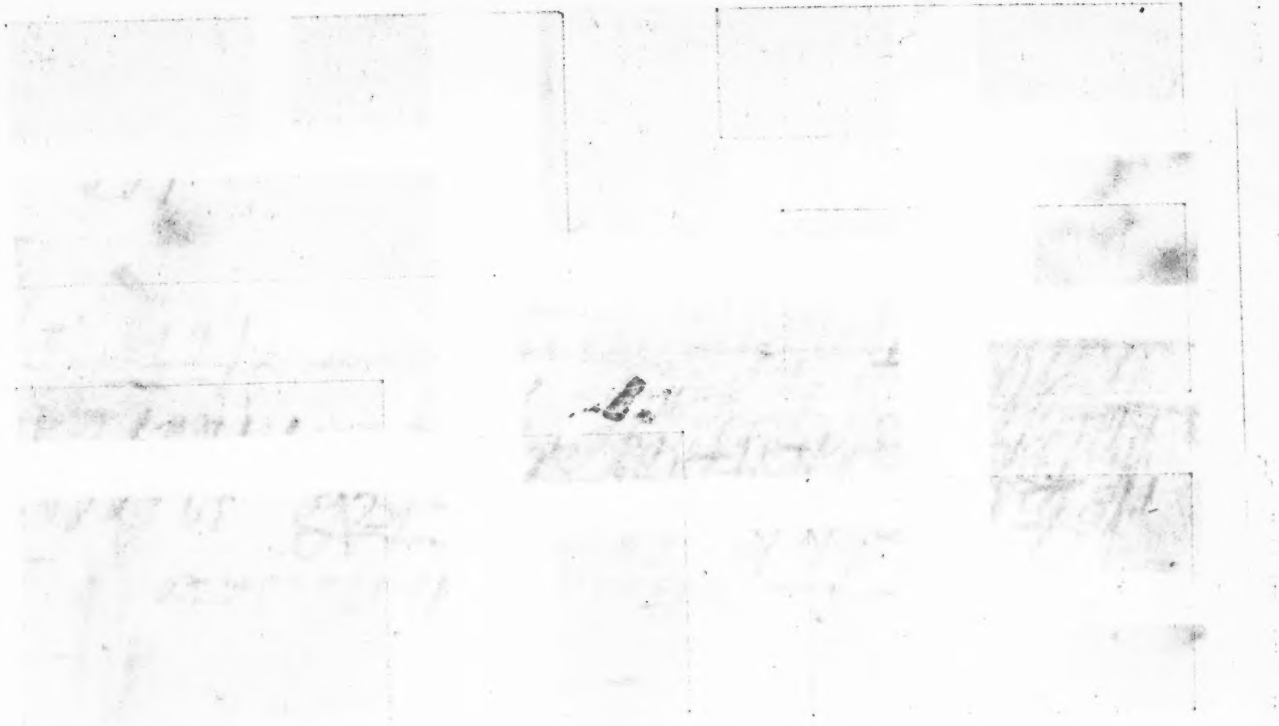

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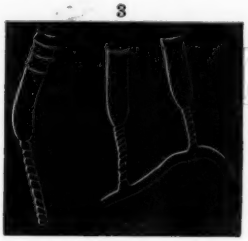

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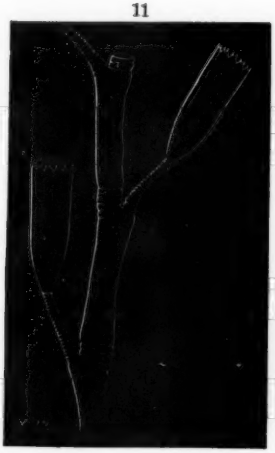

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